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Remedial Action Program
(FUSRAP)

Maywood Chemical Company Superfund Site

ADMINISTRATIVE RECORD

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of Engineers®
New York District

Groundwater Remedial Investigation
Pump Test Work Plan

New York District
Formerly Utilized Sites Remedial Action Program
Maywood Superfund Site

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Groundwater Remedial Investigation Pump Test Work Plan
FUSRAP Maywood Superfund Site
Maywood, Lodi, and Rochelle Park, New Jersey

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LIST OF ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
ALT	Advanced Logic Technologies
ATV	Acoustic Televiewer
Bgs	Below Ground Surface
BNI	Bechtel National, Incorporated
BRA	Baseline Risk Assessment
BTU/lb	British Thermal Units per pound
CDQMP	Chemical Data Quality Management Plan
cm/s	Centimeter Per Second
COCs	Constituents of Concern
DCE	Dichloroethylene
FFA	Federal Facilities Agreement
FMSS	FUSRAP Maywood Superfund Site
Ft/d	Feet per day
FUSRAP	Formerly Utilized Sites Remedial Action Program
GPM	Gallons Per Minute
GPR	Ground Penetrating Radar
GPS	Groundwater Modeling System
GWRI	Groundwater Remedial Investigation
GWRIWP	Groundwater Remedial investigation Work plan
KCS	Known Contaminated Sites
KHZ	Kilohertz
LMAS	Leaky Multi-unit Aquifer System
m	Meters
mg/l	Milligrams per liter
mg/kg	Milligram per Kilogram
MBTU/Hr	Million British Thermal Units per Hour
MCL	Maximum Contaminant Level
MCW	Maywood Chemical Works
MDA	Minimum Detectable Activity
MGD	Million Gallons Per day
MISS	Maywood Interim Storage Site
MSL	Mean Sea Level
MW	Monitoring well
NAD	North American Datum
NGVD	National Geodetic Vertical Datum

NJDCNRC	New Jersey Direct Contact Non-Residential Criteria
NJDEP	New Jersey Department of Environmental Protection
NJGWQC	New Jersey Groundwater Quality Criteria
NJPQL	New Jersey Practical Quantification Limit
PCBs	Polychlorinated Biphenols
PCE	Perchloroethylene
pCi/g	Picocuries per gram
pCi/l	Picocuries per liter
ppb	Parts per billion
PDI	Preliminary Design Investigation
PID	Photoionization Detector
ppm	Parts per million
PVC	Poly Vinyl Chloride
Ra	Radium
RCRA	Resource Conservation and Recovery Act
REE	Rare Earth Elements (Cerium, Dysprosium, Lanthanum, Neodymium and Yttrium)
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SORs	Sum of Ratios
SVOCs	Semivolatiles Organic Compounds
TAL Metals	Target Analyte List Metals
TCL	Target Compound List Organics (VOCs, SVOCs, Pesticides/PCBs)
U	Total Uranium
Th	Thorium
TCE	Trichloroethylene
TCL	Target Compound List
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USDOE	United States Department of Energy
USEPA	United States Department of Environmental Protection Agency
VOC	Volatile Organic Compound
VLF	Very Low Frequency

1.0 INTRODUCTION

The FUSRAP Maywood Superfund Site (FMSS) is located in a highly developed area of northeastern New Jersey in the boroughs of Maywood and Lodi, and the Township of Rochelle Park, New Jersey. The area consists of residential, municipal, and commercial properties that were contaminated by operations associated with thorium processing at the former Maywood Chemical Works (MCW). The three municipalities are located approximately 12 miles, (20 kilometers) north-northwest of New York City and 13 miles (21 km) northeast of Newark, New Jersey (Figures 1-1 and 1-2). The FMSS is listed on the National Priorities List (NPL) as the Maywood Chemical Company Superfund Site.

A number of properties comprise the FMSS in Maywood, Rochelle Park and Lodi, New Jersey. The properties include; the Stepan property; the Sears and immediately adjacent properties; the federally owned Maywood Interim Storage Site (MISS); and, a number of nearby commercial/government properties (Figure 1-2).

In the first half of this century, the MCW processed radioactive thorium ore (i.e., monazite sand) to produce the thorium concentrate for use in industrial products such as mantles for gas lanterns. The residues or tailings from the process operation contained low-level radioactive materials. In addition to thorium materials processing, other processing operations at MCW generated various other types of waste products (such as lanthanum, lithium compounds, detergents, alkaloids, essential oils and products from tea and cocoa leaves). MCW pumped process wastes to diked areas west of the plant and these may have migrated onto adjacent properties in Rochelle Park. In 1932, New Jersey Route 17 (Route 17) was built through parts of these disposal areas. Some of the waste materials were excavated and used as fill and mulch for nearby properties in Maywood, Rochelle Park and Lodi. Waste materials were also transported via the old Lodi Brook stream channel (later replaced by a storm water drain system) into Lodi.

The result of these activities was the deposition of MCW waste materials over much of the local area. Stepan Chemical Company, which was later referred to as Stepan Company (Stepan), bought MCW in 1959. Stepan is currently the owner/operator of a portion of the original MCW property. Many of MCW’s operations were discontinued in the 1960s and much of its original property has been sold and converted to other uses. Stepan currently focuses on the production of specialty chemicals such as ester, lubricants, food ingredients and other specialty products.

Between 1963 and 1968, Stepan undertook several onsite cleanup actions.

Contaminated material from west of Route 17 in Rochelle Park and onsite building rubble and debris were buried on portions of the Stepan property. Subsequent to these actions, areas adjacent to Stepan to the west were thought to not pose radiological concerns because the Atomic Energy Commission (AEC) released the areas for unrestricted use. However, in 1980, radiological contamination was discovered by an area resident on property immediately west of Route 17 on the Ballod property, which was formerly owned by Stepan.

From 1980 to 1983, radiological testing conducted by the State of New Jersey, USEPA, and USDOE, revealed extensive low-level radiation at several locations. Based on the results of the investigation, the Maywood Site was included on the National Priorities List in 1983. From 1984 through 1986, USDOE, acting under its authority through the 1984 Energy and Water Appropriations Act (PL 98-50), which specifically addressed the FMSS, investigated and removed over 35,000 cubic yards of soil and debris from the Ballod property (the former location of diked disposal areas west of Route 17) and 25 residential properties in Maywood, Lodi, and Rochelle Park. This material was stockpiled and secured at the MISS; the MISS was acquired by USDOE in September 1985 and is still owned by the federal government. The MISS is located on 11.7 acres of land previously owned by Stepan and abuts the Stepan property to the northwest.

1.1 Pump Test Objectives

The objective of the pump tests were presented in the *Groundwater Remedial Investigation Work Plan (GWRI), Stone & Webster Engineering Corporation, December 2000* and is presented as follows.

The purpose of this Pump Test Work Plan (PTWP) is to outline the steps necessary to perform a variable rate (step-pump test), constant rate pump test and to monitor the recovery phases of both the step-drawdown and the constant rate tests. The pumping tests will be performed in order to estimate aquifer parameters such as hydraulic conductivity, transmissivity, and storage coefficient of the overburden and bedrock aquifers, to refine the Conceptual Site Model (CSM) and for subsequent flow modeling, if required. In addition, the bedrock pumping test will provide data on anisotropy and the interconnectivity of the bedrock fractures to estimate solute transport pathways through the bedrock. Similarly, results from the pump tests will provide input parameters to dewatering calculations for the MISS and Stepan properties. Lastly, the PTWP identifies how groundwater extracted from the aquifer will be collected, treated and discharged.

The procedure for conducting aquifer pumping tests is provided in the *Chemical*

Data Quality Management Plan, Stone & Webster Engineering Corporation, February 2000, Volume 3. Standard Operating Procedure (SOP) 201 – Aquifer Testing, is presented in Appendix A to this PTWP.

1.2 Geology

1.2.1 Regional Bedrock Geology

The FMSS is located in the Piedmont Physiographic Province. The Piedmont Province in New Jersey is located within the Newark Basin. The Newark Basin extends southwestward from the Hudson River Valley in New York to southeastern Pennsylvania.

The Newark Basin is primarily composed of a sequence of sedimentary rocks, known as the Newark Group. The Newark Group consists of sandstones, shales, mudstones, and conglomerates that represent depositional cycles during the late Triassic and early Jurassic periods. The sedimentary rocks of the Newark Group lie on Paleozoic and Precambrian rocks. The sedimentary rocks represent various non-marine depositional environments. During the Triassic period, the sedimentary sequence was intruded by the igneous basalt sheet lava flows forming the Watchung, Preakness, and Hook Mountains, which resulted in the high topographic points within the rolling plains of the basin (Olsen, 1978). The sedimentary rocks have been covered by glacial, lacustrine, and fluvial unconsolidated deposits.

The sedimentary rocks of the Newark Group are divided into three formations and consist of a lower unit, the Stockton Formation; a middle unit, the Lockatong Formation; and an upper unit, the Passaic Formation (Olsen, 1978). These sediments were deposited in fluvial and lacustrine environments and grade upward from the lower, locally conglomeratic arkose (Stockton Formation) into a reddish-brown mudstone deposit (Passaic Formation).

The Passaic Formation underlies the FMSS. The Passaic Formation consists primarily of interlayered dark to moderate reddish-brown, fine-grained sandstones and siltstones. The Passaic Formation is exposed at several locations in the vicinity of the FMSS. Strike and dip were measured on outcrop locations and measurements show the strike trending NE-SW and dip angles of between 6° to 20°NW. The surface of the bedrock ranges from outcrops in Maywood, to approximately 30 feet below grade in the Kennedy Park property in Lodi. The configuration of the bedrock surface developed as a result of differential erosion, which formed elongated ridges and broad valleys. An example of a ridge feature is identified in the vicinity of monitoring well B38W05B. The draft Phase I Groundwater Data Report (Stone & Webster, 2000) presents a Bedrock Surface Elevation Map. This figure, referenced as 3-3, identifies the ridge as plunging from east to west across the MISS.

The bedrock surface generally influences the groundwater flow within the shallow bedrock as well as the topographic relief of the overlying unconsolidated materials. However, the land has been developed to a degree that most original surface features are no longer visible and geomorphologic interpretation is difficult.

1.2.2 Unconsolidated Soils (Overburden)

Generally, the unconsolidated materials (overburden) that overlie the weathered bedrock consist of sand, silt, and clay with occasional cobbles and boulders. The composition and characteristics of these deposits vary widely in relation to depositional history. For example, it has been observed (in previous investigations) in geologic borings drilled within bedrock valleys, that sand and gravel exist at depth (immediately above the weathered surface), and likely derived from the bedrock. The gravel was typically composed of rounded to subrounded pebbles of Passaic Formation sandstone. This may be indicative of stream transport and reworking. In addition, gravel-sized fragments of igneous and metamorphic rocks were also observed at various depths throughout these deposits, which may indicate glacial transport into the local area.

1.2.3 Site Specific Geology

The materials discussed above are also observed on the MISS as well as other locations south and west of the MISS where environmental and transect Geoprobes® were advanced during Phase I GWRI activities (Stone & Webster, 2000). The environmental Geoprobes® were advanced to just below the water table in most locations, which occurred on an average at approximately four to six feet below ground surface south of the MISS. Fluvial and glacial processes deposited much of the overburden soils encountered at the FMSS. However, considerable filling and reworking of soil by human activities has also occurred in the FMSS region in the past as a result of land use development.

Data collected during the Phase I investigation provided additional information on the depth and thickness of these materials in the area of the FMSS. Fill materials encountered in Geoprobe® borings across the area varied from clays to coarse sands and gravel containing brick fragments, black to blue-gray to white mottled "clayey" material (encountered in MISS area), concrete chips, wood chips, and other miscellaneous materials. The general stratigraphy and fill thickness observed during the Phase I activities are consistent with the data collected during previous site work. Figure 1-3 illustrates three cross sections through the MISS and the locations of former retention ponds and burial pits. Profiles of these layers illustrate the subsurface geology of the MISS. The fill materials generally range from five to 15 feet thick within the MISS. Below the fill, native material consists of fine-medium sand, silt and fine sand mixtures, clayey-sands and clayey gravel of medium to dark red-brown color.

Bedrock surface ranges between approximately 10 feet (MISS 7A) and 21 feet (MISS 2B) below ground surface across the MISS as reported on existing well logs. Geoprobes® advanced in this area-encountered refusal at approximately the same range of depths. Bedrock gradually rises to the ground surface moving east across Stepan property according to prior investigations and suggested by the shallow refusal depths encountered during Geoprobe® activities.

1.3 HYDROGEOLOGY

1.3.1 Regional Hydrogeology

Groundwater in the Newark Basin occurs under confined and unconfined conditions in the unconsolidated deposits and in joints, fractures, and partings in bedding planes in the consolidated rocks. Groundwater in the Passaic Formation occurs in a network of interconnected joints and fractures. The predominantly unfractured rock underlying the region has negligible capacity to store and transmit groundwater and as depth increases, the fractures and joints typically decrease in size and number as is suggested by the bore-hole geophysical data obtained during Phase I GWRI activities.

The groundwater system typically consists of a series of alternating aquifers and aquitards several tens of feet thick. The water-bearing fractures of each aquifer are more or less continuous, but hydraulic connection between individual aquifers is poor (Carswell, 1976). These aquifers generally dip downward for a few hundred feet and are continuous along the strike for thousands of feet. As stated above, regional strike and dip are reported as being NNE-SSW with dip direction and angle NNW between 6 to 20 degrees.

Groundwater in the upper Passaic Formation may occur under both confined and unconfined conditions. Where the rock is overlain by permeable materials and in upland areas, the bedrock groundwater generally occurs under unconfined conditions. Where low permeability till or stratified deposits overlie the rock, bedrock groundwater may occur under confined conditions.

Virtually all groundwater in the Passaic Formation occurs in interconnecting fractures and joints (Vecchioli and Miller, 1973). The permeability and storativity of bedrock formations in the Newark Basin are fracture-controlled, with the exception of some sandstone facies (Michalski and Britton, 1997). The prevailing groundwater flow direction within individual aquifer units tends to be near parallel to the strike of the beds.

1.3.2 FMSS Specific Hydrogeology

The shallow groundwater flow system in the FMSS is in the unconsolidated material and the shallow bedrock. Shallow bedrock wells were considered to be those wells with screen intervals approximately at elevations of 25 feet MSL and above. Groundwater occurs under unconfined and partially confined conditions. Previous studies and the Phase I investigation at the FMSS revealed that groundwater in the shallow bedrock generally appears under confined conditions toward the northeastern portions of the site. Unconfined conditions have been reported to exist toward the west and southwest portion of the Site, this will be confirmed during Phase II investigation.

The variability of fracturing and weathering within the bedrock results in differences in permeabilities in different zones in the bedrock. Groundwater flowing in water-bearing fractures at different depths below ground surface will display a range of hydraulic heads. Potentiometric head differences also occur between the unconsolidated material and the bedrock.

1.3.2.1 Bedrock

Water level measurements are obtained quarterly from 35 monitoring wells (Figure 1-3) as part of the Environmental Monitoring Program (EMP). Similarly, water levels were obtained during the Phase I GWRI activities as part of a monitoring well integrity survey and a synoptic gauging round in February and March 2000, respectively. Water levels fluctuate in response to short and long term seasonal changes in precipitation and evapo-transpiration. The minimum and maximum groundwater level elevations for each gauging round (June 1999 through June 2000) are presented in Table 1-1. Table 1-1 presents bedrock well construction details such as: northing/easting coordinates, ground surface elevation, top of riser elevation, depth and elevation to the top/bottom of the well screen or open-hole where applicable, and the depth to bedrock/elevation of bedrock. The table also contains information from six gauging rounds and provides the depth to water relative to ground surface/top of riser and referenced to mean sea level (MSL). As indicated in the table, with the exception of

B38W6B and B38W15D which were gauged once over during the 1999 synoptic gauging year, the minimum water level fluctuation was noted in B38W14D (1.21 ft), and the maximum water level fluctuation was noted in B38W02D, where the water level was noted to fluctuate by 9.14 feet.

Shallow groundwater flow at the MISS is strongly influenced by the morphology of the bedrock surface. The bedrock slopes westward across the site. Bedrock topographic highs exist in the middle and eastern portion of the site and are expressed as ridges that rise within the Stepan property to the east. These bedrock highs form a local groundwater divide, and influence the direction of groundwater flow in the shallow bedrock aquifer as seen on the shallow bedrock potentiometric surface map (Figure 1-4). Figure 1-4 presents a plot of the potentiometric surface for bedrock monitoring wells situated in the upper bedrock (typically 25 feet above Mean Sea Level (MSL)), for water levels obtained on March 27, 2000. The direction of groundwater flow as indicated in Figure 1-4, is dictated by the presence of a groundwater high, which strongly coincides with a bedrock high located in the northeast corner of the site in the vicinity of the Stepan property. The divide shows one component of groundwater flowing predominantly to the west-southwest, and a second component of groundwater flow to the northwest. This is supported by the presence of the gently plunging bedrock ridge trending east-west through the MISS.

Groundwater flow in deeper bedrock wells (wells completed at elevations below 25 feet MSL) are not affected by the bedrock surface features. These features become hydraulically insignificant with depth and flow is controlled predominantly by the deeper fracture system orientation and connectivity. For comparison purposes, a bedrock potentiometric surface map has been developed using both shallow and deep bedrock groundwater data obtained on March 27, 2000 (Figure 1-5). Similarly, Figure 1-6 shows the deep bedrock flow direction to be in a west-southwest direction towards Saddle River.

The horizontal hydraulic gradient measured in the shallow bedrock aquifer, ranged between 0.005 to 0.020 ft/ft. The hydraulic conductivity of the bedrock was estimated during Phase I GWRI activities to be between $2.0x10^{-4}$ cm/s (0.57 ft/day) and $4.6x10^{-4}$ cm/s (1.30 ft/day). These values exhibit hydraulic conductivity values that are cited in Freeze and Cherry in similar consolidated material, i.e., sandstone and shale. As part of Phase II GWRI activities, pressure packer tests performed in bedrock boreholes have been initiated and results from seven bedrock borings indicate that hydraulic conductivity range from $3.9x10^{-4}$ cm/s (1.1 ft/day) to $1.1x10^{-3}$ cm/s (3.2 ft/day). These results are representative of both matrix and fractured bedrock media. The results of the pressure packer tests including the procedures used to perform the tests will be presented in the Groundwater Remedial Investigation Report.

The average linear groundwater velocity in the bedrock was estimated to range from 0.017 ft/day to 0.4 ft/day. The average linear groundwater velocity of the bedrock has previously been estimated to range between 0.3 to 2 ft/day (DOE 1992).

1.3.2.2 Overburden

The saturated thickness in the unconsolidated material at the MISS ranges from five feet to 15 feet. Overburden thickness generally increases to the west and thins to the east on the bedrock high in the vicinity of the Stepan property. Table 1-2 contains information regarding well construction details such as: northing/easting coordinates, ground surface elevation, top of riser elevation, depth and elevation to the top/bottom of the well screen and sump length, where applicable. The table also contains information from six gauging rounds and provides the depth to water relative to ground surface/top of riser and referenced to mean sea level. As indicated in the table, with the exception of B38W15S which was gauged once during the 1999 synoptic gauging year, the minimum water level fluctuation was noted in B38W14S (0.76 ft), and the maximum water level fluctuation was noted in MISS-2A, where the water level was noted to fluctuate by 6.86 feet over the course of the synoptic gauging year.

A water table contour map based on water levels collected on March 27, 2000 is presented as Figure 1-7. The direction of groundwater flow in the overburden aquifer is predominantly to the west-southwest towards the Saddle River. The direction of groundwater flow to the west and to the south of the Site, and the effects of Westerly and Lodi Brooks will be further defined as additional overburden and bedrock monitoring wells are installed as part of the Phase II GWRI investigation.

In the unconsolidated material, the horizontal hydraulic gradient varies spatially from approximately 0.007 ft/ft to 0.012 ft/ft. In-situ permeability tests (rising and falling head) were used to evaluate hydraulic characteristics of the unconsolidated deposits and to compare results to previous study results. The permeability test data indicated that the hydraulic conductivity of the overburden materials ranged between 8.8×10^{-5} cm/s (0.25 ft/day) to 1.4×10^{-4} cm/s (0.4 ft/day). These values exhibit hydraulic conductivity values found in Freeze and Cherry in similar unconsolidated material, i.e. ranging from silt to silty sands. Similarly, results reported from previous hydraulic conductivity tests conducted on Stepan monitoring wells in 1994 (Stepan, 1994) yielded similar results.

The average linear groundwater velocity in the overburden was estimated to range from 0.0125 ft/day to 0.02 ft/day. The average linear groundwater velocity of 0.05 ft/day has previously been estimated for the unconsolidated sediments (BNI, 1992).

2.0 PUMP TEST OBJECTIVES

As indicated in Section 1.1, the purpose of the aquifer tests is to estimate aquifer properties for both the overburden and bedrock aquifers and to refine the CSM and estimate transport pathways and rates of migration of contaminants in groundwater. It is currently anticipated that a step rate pump test and constant rate pump test will be conducted for both the overburden and bedrock aquifers. Similarly, as part of the step and constant rate pump tests, the recovery phase will be measured. Drawdown measurements shall be recorded using both pressure transducer/data logger and limited manual measurements.

The pump tests are presently planned to be performed in various phases. The first phase will consist of step rate pump tests, followed by the constant rate pump tests. Prior to performance of the pump tests, installation of an overburden and bedrock test well, and nine overburden piezometers and eight bedrock observation wells will be installed. The proposed schedule for the pumping well/piezometer installation, and pump test execution is presented in Appendix B. In addition to the installation of the piezometers/observation wells, groundwater level measurements will be obtained from select existing monitoring wells during the pumping tests.

2.1 Pumping Well Installation

Prior to the execution of the step and constant rate pump tests, two pumping wells will be installed. The proposed location of the pumping wells, PW-1S and PW-1D, are depicted in Figures 2-1 and 2-2. The overburden pumping well, PW-1S, will be constructed in accordance with the *New Jersey Department of Environmental Protection and Energy, Field Sampling Procedures Manual, May 1992.*

The overburden pumping well borehole will be advanced using the drive and wash drilling technique. Eight-inch diameter drill casing will be advanced through the overburden, with continuously collected split-spoon samples obtained for lithologic characterization. The casing will be cleaned out using wash (water) rotary drilling, and the casing will then be advanced. Upon encountering refusal, a four-inch diameter polyvinyl chloride (PVC) well screen and riser will be installed within the casing. It is presently anticipated that the well screen will consist of continuously wound 10 slot openings and will be constructed of schedule 40 PVC. Sand pack material will consist of either Morie 0 or 00 sand. The remainder of the well will be constructed in accordance with NJDEP criteria. The overburden pumping well screen will fully penetrate the saturated zone.

The bedrock pumping well borehole will be advanced using 10-inch I.D. Hollow Stem Augers. The interior of the augers will be cleaned out using a nominal 10-inch diameter tri-cone roller bit. Upon encountering bedrock, the roller bit will advance a hole a minimum of 10 feet into bedrock and a six-inch diameter steel casing will be grouted in place. Following installation of the casing, and allowing for the grout to set, the borehole will be opened to the formation using a six-inch diameter air hammer to a depth of approximately 100 feet in order to achieve excess capacity. A drillers' yield will be obtained after advancing the borehole every 25 feet, and at the base of each major fracture interval. Given that the drillers yield is a maximum yield, drilling would continue until a yield of approximate 30 gallons per minute (gpm) is obtained, or 100 foot open borehole depth is achieved, whichever occurs first.

Based on preliminary calculations, using Neuman (Charbeneau, 2000), refer to Table 2-1, an observable drawdown at a distance of approximately 30 to 50 feet from the pumping well would require a hydraulic head of the pump, in bedrock, of approximately 75 feet. This is based on a bedrock hydraulic conductivity of approximately 1.0 to 3.0 ft/day. The variables modeled to identify flow rates necessary to achieve drawdown at a distance of 30 feet to 50 feet are presented in Table 2-1.

The proposed bedrock pumping well, PW-1D, may require an open borehole of up to 100 feet. This should prevent the dewatering of the well at projected flow rates during the step drawdown and/or the constant rate pump test, and will account for matrix hydraulic conductivity less than 1.0 ft/day.

Consideration has been given to the issue of cross-contamination by USACE, given the projected length of the open borehole. Given the seepage velocity determined for the bedrock aquifer (0.017 ft/day to 0.4 ft/day), under non-pumping conditions, and the limited duration of the pump tests, it does not seem likely that the pumping induced stress on the bedrock aquifer will result in cross-contamination between units/layers. A one dimensional analytical groundwater flow model, Pumpit ™, was used to determine the capture zone generated from the proposed bedrock pumping well, PW-1D. In-put parameters used in the simulation are consistent with aquifer parameters previously described and assume homogenous and isotropic aquifer conditions. The analysis indicates that based on pumping well PW-1D for 3 days, a maximum capture zone of approximately 25 feet would be established, as depicted by the particle tracks. The capture zone is depicted in Figure 2-3. As depicted in the figure, none of the existing monitoring (USACE/Stepan) wells are located within 25 feet of the pumping well. However, three well clusters, B38W19S/19D, B38W25S/25D, and MISS-7A/7B, are located within 200 feet of the proposed pumping well.

Radiological and volatile organic data for these monitoring wells obtained from the November 2000 groundwater sampling program are presented in Figure 2-3. As depicted in Table 2-2, several VOCs were present in the groundwater monitoring well samples. However, only chlorobenzene was present in monitoring well sample MISS-5B at a concentration greater than the NJ Groundwater Quality Criteria. Based on the distance of this well (150 feet) to the proposed pumping well, contamination present in this monitoring well will not reach the pumping well during the course of the pumping test. Following conclusion of the recovery phase of the pump test, groundwater flow from this well will be away from the pumping well.

With respect to radiological parameters, total uranium was detected in a groundwater sample obtained from bedrock monitoring well MISS-5B during Phase I GWRI activities at a concentration of 82.23 pCi/L, and at a concentration of 73.48 pCi/L in well MISS-5A in November 2000 (Phase II) above the State/Federal MCL of 27 pCi/L. Existing wells MISS-5A/5B are located approximately 150 feet southwest of the pumping well. The projected change in groundwater gradient and resultant flow toward the well were simulated using Pumpit™. Figure 2-3 shows the projected well capture zone and particle tracking lines. From this simulation, a seepage velocity of 1 ft/day was calculated from the hydraulic gradient, as measured 150 feet from the test well. This velocity does not consider the uranium transport retardation factor in groundwater. Therefore, there does not appear to be a concern that contaminants present in MISS-5A/5B will migrate to the pumping well and subsequently be disseminated into the lower reaches of the aquifer, during the course of the pumping and recovery phases of the test.

After collection of the pump test data, the bedrock pumping well will either be grouted such that the open borehole does not extend beyond 25 feet in order to avoid cross-contamination issues, or the well will be grouted and abandoned. It is anticipated that the grouting of the bedrock pumping well will be accomplished by mid-late July 2001, or approximately 90 days after well installation. If the well is abandoned, a well abandonment form will be submitted to the NJDEP Bureau of Water Allocation.

2.2 Overburden Piezometer Installation

Using the Neuman method of analysis, (Charbeneau, 2000) refer to Table 2-4, it was determined that the existing monitoring well network at the MISS would be insufficient to identify drawdown given the distance between the existing monitoring wells and the proposed pumping well. Therefore, it is anticipated that nine overburden piezometers (Micro-wells) will be installed. Three of the Micro-wells will be installed at a distance of 10 feet, 30 feet and 100 feet hydraulically down gradient (parallel to groundwater flow) from the pumping well, while one Micro-well will be installed 10 feet hydraulically upgradient of the pumping well, PW-1S. Similarly, five piezometers will be installed normal to groundwater flow along the same equipotential line. Four will be installed at a distance of 10 feet, 30 feet, 100 feet and 135 feet from the pumping well in a southerly direction, while another piezometer will be installed to the north of the pumping well, PW-1S, at a distance of 10 feet. The piezometer located at a distance of approximately 135 feet south of PW-1S, and similarly along a line trending 45 degrees west of strike at a distance of 15 feet from PW-1D, is being installed in order to provide additional information on the relationship among the interconnectivity of the overburden/bedrock flow system. Orientating the wells in this type of array will assist in determining if there is aquifer heterogeneity/anisotropy. The location of the proposed Micro-wells is presented in Figures 2-1 and 2-2.

The overburden piezometers will be installed using a direct push Geoprobe® Rig. Soil samples will be collected continuously from grade to refusal using a Geoprobe® Large Diameter Borehole (LDB) Sampler, which measures approximately 2.5-inch in diameter. After extracting the drill rods, a 1-inch diameter, 10-slot PVC well screen will be placed in the open borehole, and formation material will be allowed to collapse around the screen. If the borehole stays open, the piezometer will be constructed with a sand pack, bentonite seal, and cement-bentonite slurry. Based on grain size data, the screens will consist of 10-slot (0.010-inch) openings in order to limit the infiltration of formation fines into the screen. The screens will fully encompass the saturated zone. If a sand pack cannot be emplaced around the well screen, consideration will be given at development to pumping the well at a lower rate in order to prevent an influx of sediments into the well.

2.3 Bedrock Observation Well Installation

Eight bedrock observation wells will be installed prior to the execution of the pump tests. The observation wells will be used to measure changes in hydraulic heads, and will not be used for groundwater sampling. The bedrock observation wells will be advanced using 10-inch I.D. Hollow Stem Augers through the overburden. The interior of the augers will be cleaned out using a nominal 10-inch diameter tri-cone roller bit. Upon encountering bedrock, the roller bit will be advanced a minimum of 10 feet into bedrock and a six-inch diameter steel casing will be grouted in place. Following installation of the casing, and allowing for the grout to set, the borehole will be opened to the formation using a six-inch diameter air hammer to a depth of approximately 100 feet. The bedrock observation wells will be extended to a depth equal to that of the pumping well in order to avoid the effects of partial penetration, and to potentially encounter the same fracture system. As a result, the observation wells will also have an open borehole extending beyond 25 feet.

After collection of the pump test data, the bedrock observation wells will either be grouted so that the open borehole does not extent beyond 25 feet or the well will be grouted and abandoned. It is presently anticipated that the grouting of the observation wells will be accomplished by mid-late July 2001 or approximately 90 days after well installation. If the wells are abandoned, a well abandonment form will be submitted to the NJDEP Bureau of Water Allocation.

A reconnaissance identified two intact bedrock outcrops in proximity to the site. One large outcrop was measured along Summit Avenue at the intersection with the New York Susquehanna Railroad crossing in Hackensack, NJ. This outcrop is located approximately 3000 feet east of Maywood Avenue and West Hunter Avenue in Hackensack, NJ. At this outcrop the bedrock had a strike of N26^{o}E with a dip direction of 14^{o}-19^{o} NW. A second, small outcrop was measured along Passaic Street near Lawrence Avenue in Maywood, NJ. This outcrop located approximately 2500 feet north of the MISS, had a strike orientation of N36^{o}E with a dip direction of 6^{o} NW. The locations of the mapped outcrops are presented in Figure 2-4.

Strike and dip data collected from the former (Summit Avenue) outcrop location is considered more accurate, and accordingly, was used to define the spatial arrays for the bedrock observation wells.

The bedrock observation wells will be constructed principally along two arrays, one array will be along dip, and one array will be constructed along strike, refer to Figure 2-1 and 2-2. Three observation wells will be constructed down dip of the pumping well at a distance of 10 feet, 30 feet and 100 feet. Similarly, one bedrock piezometer will be installed 30 feet up dip of the pumping well, PW-1D. Along strike, bedrock observation wells are proposed at distances of 10 feet, 30 feet and 100 feet from the pumping well in a northerly direction. An eighth observation well will be installed oblique to strike by approximately 45 degrees.

2.4 Well Development

Following installation of the overburden and bedrock pumping wells, each pumping well shall be vigorously developed to provide maximum well efficiency and flow. Proper development should minimize the effect of increasing well efficiency (self development) during the pump testing, which can adversely impact pump test results. Each pumping well will be developed using the pump and surge method, in which the well will be surged and pumped three to four times, each cycle lasting approximately two hours. At the conclusion of each pumping cycle, the specific capacity of the well will be calculated at a constant discharge rate in order to provide a comparison of well efficiency as the well is further developed. Well development will continue until minimal changes are noted in the well specific capacity.

All piezometers/bedrock observation wells shall be developed to improve the hydraulic communication between the pumping well and the aquifer. The wells will be developed to remove fine grained sediments entrained within the observation wells. Bedrock observation wells shall be developed using the pump and surge method, while the overburden piezometers will be developed with a peristaltic pump due to the small diameter of the Micro-wells. All wells shall be developed until they are principally turbid free per NJDEP requirements (May 1992).

Recovery of water lost during well installation is not proposed since the wells are not intended for sampling.

All development water will be containerized on-site in holding tanks and then pumped to a 20,000 gallon fractionalization tank and batch tested. Water that does not meet POTW pre treatment standards will be treated by filtering and granular activated carbon (GAC) or other treatment process. All treated water will be tested to ensure that the requirements of the POTW are achieved prior to disposal.

It is anticipated that the volume of water that will be generated from well development and from the step/constant rate pump tests are on the order of 125,000 gallons. This is based on a pumping rate of 1 gpm for the step rate and constant rate test in the overburden aquifer, and an average pumping rate of 15 gpm and 20 gpm for the performance of the step rate and constant rate test in the bedrock aquifer.

2.5 Pre-Pumping Trend Evaluation

Prior to performing the constant rate pump test, a pre-pumping trend evaluation will be performed in order to determine effects of precipitation/barometric pressure on water levels in the proposed observation wells.

To correct pumping induced drawdown data for any natural fluctuations in water levels caused by changes in barometric pressure/precipitation events, barometric pressure and precipitation data will be obtained and incorporated into the water level measurements. Commencing one week prior to the constant rate pump tests, groundwater water level data will be collected at observation wells located within approximately 150 feet of the pumping wells, PW-1S/PW-1D. An upgradient control well, far outside the radius of influence, will also be monitored before and during the constant rate test. Water levels and if necessary, barometric pressure, will be obtained using a pressure transducer set to a linear time scale mode. Water level measurements will be obtained at 1-hour intervals. Presently, precipitation and barometric pressure data is obtained from a weather station located at the Teterboro Airport located approximately 3 miles southeast of the site in Wood-Ridge, New Jersey. Barometric and precipitation data collected from the airport will be obtained from the National Climatic Data Center, preventing the necessity to collect barometric pressure data with a pressure transducer. Barometric and other climatic data is measured hourly at the airport.

Natural fluctuations in the water table may be due to precipitation recharging the water table, the lack of precipitation, barometric pressure changes or other influences. Plots of barometric pressure changes will be compared with plots of water elevation data and precipitation data to identify any trends and related causes. These trends, if present, will be evaluated in such a way as to allow correction of water levels recorded during the pumping and recovery phases of the tests. If a barometric pressure correlation is identified, correction factors will be prepared using a linear regression method or using a simpler antecedent trend projection method.

2.6 Step Rate Pump Tests

2.6.1 Overburden Aquifer Step Rate Test

Variable rate flow tests will be performed on pumping well PW-1S. The purpose of the step pump test is to identify a discharge rate that can be sustained during the constant rate test at each well. In addition, the step test can be used to estimate aquifer hydraulic conductivity and transmissivity from drawdown/recovery data collected at both the pumping and observation wells. The variable rate test will be conducted by pumping water from the well at successively greater rates for a uniform fixed period of time (e.g., steps). Step duration will typically not last more than two hours, during which the discharge rate and drawdown in the pumping well and nearby observation wells will be gauged. As the water level in the pumping well levels off and becomes asymptotic with respect to time, the pumping rate will be increased or stepped to the next higher flow rate. Periodically, the flow rate will be confirmed by timing the rate required to fill a known volume. It is tentatively anticipated that existing monitoring wells located within a 150 foot radius of the pumping well will be gauged during the performance of the step rate test, (refer to Figure 2-1).

It is anticipated that four steps will be performed with initial pumping rates commencing at approximately 500 milliliters per minute (mL/min) and increasing (stepping up) the flow rate to a maximum 2 gallons per minute (gpm). The low pumping rates are necessary due to the limited saturated thickness of the overburden aquifer at the site, and the hydraulic conductivity/specific yield of the soils. Using the Neuman method (Charbeneau, 2000) for an unconfined aquifer, an initial pumping rate was determined using slug test data (hydraulic conductivity), aquifer saturated thickness and available drawdown. The analysis is presented in Table 2-4, and indicates that based on modeled hydraulic conductivity values and specific yield values, pumping rates will likely not exceed 2 gpm.

This information was then used to determine the theoretical drawdown that would be noted in adjacent observation wells. The model shows that measurable drawdown in observation wells beyond 30 feet maybe limited. As a result of this modeling process, nine overburden piezometers are proposed for installation in order to measure changes in hydraulic head as a result of stressing the aquifer. Four piezometers will be installed parallel to groundwater flow; three of the wells will be situated in a down gradient direction at distances of approximately 10 feet, 30 feet, and 100 feet from the pumping well, PW-1S, while one well will be located approximately 10 feet hydraulically upgradient of the pumping well, PW-1S, along the same array. Similarly, five piezometers are proposed for installation normal to groundwater flow along the same equipotential line at a distance of 10 feet, 30 feet, 100 feet and 135 feet south of the pumping well, with the fifth piezometer located 10 feet north of the pumping well along the same array (refer to Figures 2-1 and 2-2).

Water level data (i.e., drawdown) will be collected with the aid of pressure transducers (In-Situ PXD transducers) coupled to a Hermit 2000/Hermit 3000 or Mini-Troll. The data logger will be programmed to collect data at predefined times so that a minimum of 10 measurements are recorded per log cycle (i.e., 0 to 1 minute, 1 to 10 minutes, 10 to 100 minutes, 100 to 1000 minutes and 1000 to 10,000 minutes). Pressure transducers will be installed in the pumping well, PW-1S, and all existing overburden monitoring wells located with a 150 foot radius of the pumping well (refer to Figure 2-1). Where feasible, USACE will try and minimize the number of pressure transducers used, and maximize the number of transducers that have eight channel capabilities. This will result in fewer dataloggers requiring to be manually reset when the pumping well is stepped to the next higher incremental rate, and thereby missing critical early time data.

After completion of the various steps, the step test will be terminated and the recovery phase of the step test will commence. The recovery portion will be terminated after the water level has returned to within 90% of the static water level or until the water level is within 0.01 feet of difference in water levels measured over three hourly measurements.

Following the completion of the variable rate flow/step test, the specific capacity of the well will be calculated and used to estimate a sustainable flow rate for the constant rate tests. Similarly, the results of the test may provide sufficient information to indicate that a constant rate test for the overburden aquifer is not required.

2.6.2 Bedrock Aquifer Step Rate Test

A step rate pump test will be conducted on pumping well PW-1D, following completion of the step test conducted on PW-1S. Following water level recovery in well PW-1S, both overburden and bedrock wells located within a 150 foot radius of PW-1D will be included in the test in order to gauge the change in hydraulic head in response to pumping conditions, (refer to Figure 2-1).

Using the Neuman method, an initial pumping rate for the bedrock aquifer step test was derived. This information is presented in Table 2-1 and indicates that a pumping rate of approximately 15 gpm is feasible based on an available saturated thickness of 100 feet, and the hydraulic conductivity and specific yield cited for the bedrock aquifer. With the proposed deepening of the pumping well, it appears feasible to pump the well upwards of 20 gpm due to the increased aquifer thickness (borehole length) and available drawdown. Based on the results of the specific capacity tests that will be performed on the bedrock pumping well, an initial pumping rate will be selected. Presently, four steps are planned to be incorporated into the variable rate test with each step typically ranging from 1.5 to 2 hours. Pumping rates may range from 10 gpm to 25 gpm, and will be dependent on the specific capacity tests. Each phase of the test will be stepped to the next incremental rate after the water levels in the pumping well levels off and becomes asymptotic with time. Where feasible, USACE will try and minimize the number of pressure transducers used, and maximize the number of transducers that have eight channel capabilities. This will result in fewer dataloggers requiring to be manually reset when the pumping well is stepped to the next higher incremental rate, and thereby missing critical early time data. After completion of the various steps, the step test will be terminated and the recovery phase of the step test will commence. The recovery portion will be terminated after the water level has returned to within 90% of the static water level or until the water level is within 0.01 feet of difference in water levels measured over three hourly measurements.

Information obtained from the step test will be useful in determining an optimal pumping rate for the constant rate test. An estimate of aquifer hydraulic conductivity and transmissivity can be determined from both the drawdown and recovery data at both the pumping and bedrock observation well. As depicted in Table 2-1, the radius of influence can be projected depending on the pumping rate, hydraulic conductivity, specific yield, and available drawdown in the pumping well.

Also provided is information regarding interconnectivity of fractures within the bedrock aquifer and the hydraulic relationship between the overburden/bedrock aquifer, may be determined. For example, if drawdown is detected in an overburden observation well during the execution of the bedrock pumping test, information on the hydraulic relationships of the two formations can be ascertained.

2.7 Constant Rate Pump Tests

Constant flow tests will be completed at extraction wells, PW-1S and PW-1D. The purpose of the constant rate pump tests is to calculate the hydraulic properties of the unconsolidated overburden aquifer and the upper 100 feet of the bedrock aquifer. The constant rate pump tests will stress the aquifer over an extended period of time, upwards of 72-hours.

In addition to determining the transmissivity, hydraulic conductivity, and storage coefficient of the aquifers, information obtained from the constant rate tests will be useful in the future for designing dewatering systems, capture zone analysis, and for use in fate and transport analysis.

The tests will be performed by pumping each well independently for a predetermined flow rate, as determined from the step-drawdown tests, while monitoring the flow rate and resultant drawdown in the pumping wells and associated observation wells. In addition to the newly installed Micro-wells, monitoring wells that will be included in the overburden pump test include the USACE/DOE “A” and “S” series wells depicted in Figure 2-2, whereas, during the execution of the bedrock pump test in addition to the newly installed bedrock piezometers, the “A”, “S”, “B” and “D” series wells will be gauged. The “A” and “S” series wells are overburden wells, while the “B” and “D” series wells are bedrock monitoring wells. Additionally, Stepan overburden monitoring wells OBMW-19 and PT-2S, and bedrock monitoring well BRMW-1, located in the Former Aromatics area, refer to Figure 2-2 will be included in the pump test.

It is anticipated that a minimum 24 hour period will elapse between the overburden and bedrock step tests. Similarly, there will be a minimum one week period between the overburden and bedrock constant rate tests. The constant rate tests are scheduled for 72 hours, however, the tests may be extended a maximum 12 hours if a significant aquifer boundary is detected near the conclusion of the 72-hour test period. This would allow the collection of sufficient data (four log cycles at 240 minutes) to calculate late time aquifer parameters.

Water level data (i.e., drawdown) will be collected with the aid of pressure transducers installed in each observation well coupled to an automated data logger. The data logger will be programmed to collect data at predefined times so that a minimum of 10 measurements are recorded per log cycle (i.e, 0 to 1 minute, 1 to 10 minutes, 10 to 100 minutes, 100 to 1000 minutes and 1000 to 10,000 minutes). As previously discussed, where feasible, USACE will try and minimize the number of pressure transducers used, and maximize the number of transducers that have eight channel capabilities. This will result in fewer dataloggers requiring to be manually reset when the pumping well is stepped to the next higher incremental rate, and thereby missing critical early time data.

Manual water level measurements will also be collected at most site wells in case the data logger malfunctions and data are lost. Pumping well drawdown will be continuously measured during the constant rate test to check that the pump does not become exposed. Well head and adjacent piezometer water levels will also be continuously recorded on a semi-log time-drawdown plot in order to mark potential aquifer boundaries during the test.

Immediately prior to the completion of the constant rate pumping tests, the pressure transducers will be stepped, i.e., reset with respect to time in order to record the start up of the recovery phase of the test. Recovery test data often provide the best estimate of aquifer properties as the data are unaffected by variations in pumping rates. The recovery tests will be performed by recording water level data in the pumping wells and associated observation wells at the same frequency as during the pumping test once the pump is shut off. Recovery measurements will be collected for a period equal to the duration of the pump test.

2.8 Contingencies

Prior to the performance of the pump tests, the contractor will verify that the lithium batteries in the dataloggers are in good shape and are fully charged. Similarly, to confirm that the dataloggers are obtaining accurate water levels, manual water level measurements will be taken at comparable time intervals and compared to the datalogger values. This will ensure that if the datalogger malfunctions, sufficient data would be obtained from the manual measurements to determine aquifer parameters. As noted in Section 2.7, the pumping tests shall be continuously manned to manually measure water levels. During this time, site personnel would also check and record discharge flow, maintain the pump generator, and inspect the discharge line and water storage tank(s).

With respect to the power supply for the submersible pump, a back up generator will be available in case of primary generator malfunction. A sufficient supply of gasoline will be stored onsite to complete each test. If the generator does go down during the test, the pumping down time will be recorded and factored into the equations necessary to determine aquifer parameters by utilizing a varying pumping rate in the flow equations. Similarly, a backup submersible pump and electronic measuring device would be maintained onsite in case of equipment malfunction.

In order to minimize the potential of a partial well collapse and/or pump fouling during testing, a fully penetrating 4-inch ID, 40-slot PVC screen may be inserted into the base of the bedrock borehole. The submersible pump will be installed near the base of the PVC screen. Installation of a filter pack is not proposed in order to minimize well loss and facilitate removal of the PVC screen and riser after pump testing. Well loss through the 40-slot screen is considered negligible.

In the event that the pump test is interrupted due to pump or generator equipment failure, consideration will be given to "stepping" the dataloggers and collecting recovery data. The lead hydrogeologist will then be contacted to determine whether to continue or stop the pumping test.

It is anticipated that less than 100,000 gallons will be generated from the constant rate pump test from the bedrock aquifer. Accordingly, a sufficient number of 20,000-gallon holding tanks will be made available for the tests.

Due to the extended nature of the pump tests, a sufficient number of staff personnel will be necessary to man the test. A staffing schedule will be prepared outlining personnel roles/responsibilities and will include contact phone numbers of key test staff. The health and safety plan will be reviewed by test staff prior to test startup to ensure that appropriate lighting and other precautions are being taken when working at night.

3.0 DATA ANALYSIS

Upon completion of the step drawdown and the constant rate pump tests, the data from each test will be evaluated in order to determine aquifer characteristics. As indicated previously, preliminary estimates of hydraulic conductivity and transmissivity can be obtained from step drawdown tests if drawdown is identified in an adjacent observation well. Furthermore, the optimal pumping rate based on the amount of available drawdown, can be determined and used as the pumping rate for a constant rate pump test. In addition to hydraulic conductivity, transmissivity, and storage coefficient can be obtained from a constant rate pump test. Similarly, information regarding interconnectivity can be obtained based on distance-drawdown measurements from the bedrock pump tests.

Analytical solutions using graphing procedures, presented in *Analysis and Evaluation of Pumping Test Data,* (Kruseman and deRidder, 1994), presents many analytical graphing solutions for step rate and constant rate pump tests including the recovery phase of the tests.

Appropriate aquifer testing software such as Aquifer Test (Waterloo Hydrogeologic, Inc.) or AQTESOLV (Geraghty & Miller, Inc.) which utilizes analytical methods such as Birsoy-Summers or Cooper-Jacob for analysis of step drawdown data, and the Theis or Neuman method for analysis of constant rate pumping test data for the determination of aquifer hydraulic properties may be used to evaluate the data.

The results of the short term and constant rate pump tests will be described and presented in the Groundwater Remedial Investigation Report.

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TITLE:	**NO.:**	SW-MWD-201-0
Aquifer Testing	**PAGE**	1 of 3
	DATE:	May 1999

APPROVED:

Project Manager

Project Engineer

1.0 INTRODUCTION

This procedure presents a technique for calculating the Transmissivity and Storativity of an aquifer with an aquifer test. It is intended for use on the FUSRAP Maywood Superfund Site.

2.0 LIMITATIONS

This Standard Operating Procedure (SOP) should be used in conjunction with task-specific work plans involving aquifer testing.

3.0 EQUIPMENT

- A pump, capable of pumping and maintaining the expected discharge rates, will be installed in the well.
- The discharge will be directed into a tank capable of holding the volume of water produced during the aquifer test.
- A throttle valve will be installed in the discharge line to control the pumping rate.
- An in-line water meter, capable of accurately (+/-5%) measuring the pumping rate, will be installed in the discharge line. The water meter will be calibrated within one month of the aquifer test. The water meter will be installed ten feet from the throttle valve so that the turbulent flow from the valve does not affect the accuracy of the water meter.

- A sampling port will be installed in the discharge line, after the water meter, to collect groundwater samples.

- A stilling tube will be installed in the test well to the top of the pump.

- Pressure transducers will be installed at the bottom of the stilling tube in the test well and at the bottom of each monitoring well. The transducers will be connected to a hermit data logger.

- A rain gage will be installed at the site to measure the precipitation before, during, and after the aquifer test

- A barometric probe attached to the hermit datalogger will be used at the site to measure the barometric pressure before, during, and after the aquifer test.

- An electronic water level indicator will be used to manually measure the water level in the test well and in each monitoring well.

- A stop watch will be used to determine when water level measurements will be collected during the aquifer test.

4.0 METHODOLOGY

4.1 Background Monitoring

The water level in the test well and selected monitoring wells will be measured hourly three days before the start of the aquifer test to determine regional trends in the water level and to check if there is any nearby pumping which may influence the water levels during the aquifer test. This will be done by installing a pressure transducer in the test well and selected monitoring wells. The pressure transducers will be connected to a data logger that will collect water level measurements.

The data will be downloaded to a computer and graphed to determine the long-term regional trends and to check if there is any nearby pumping that would affect the water levels during the aquifer test. If nearby pumping is affecting the water levels, then the owners will be contacted and asked to either turn off the pumps or hold the pumping rates constant during the aquifer test, if possible.

Barometric pressure will also be monitored on site three days before the aquifer test with a recording barometer. Barometric pressure measurements will be collected hourly.

If surface water is located within the anticipated radius of influence of the aquifer test, then a staff gage will be installed in the surface water and water levels will be measured from the staff gauge hourly during the three day pre-test monitoring.

Other relevant activities at the site and surrounding areas should also be noted if they may have an impact on the results of the test, for example excavations, water discharges, surface water ponding, and surface water diversions.

4.2 Step Drawdown Test

A step drawdown test will be conducted in the test well to determine the pumping rate for the aquifer test. This will be done by pumping the test well at five evenly spaced pumping rates each for 100 minutes. Water level measurements will be collected on a logarithmic time schedule from the start of each step and plotted on semi-logarithmic graph paper. The water levels measured during the second, third, fourth, and fifth steps will be corrected for the effects of the proceeding steps. The pumping rate that uses the most available drawdown but does not cause the water level to drop below the pump before the end of the aquifer test will be selected for the constant rate aquifer test.

4.3 Aquifer Test

Start the aquifer test and measure the pumping rate and water levels in the test well and monitoring wells manually on a logarithmic time schedule. Adjust the throttle valve in the discharge line as frequently as needed to maintain a constant-rate. Continuous water level measurements will be obtained and recorded using pressure transducers and data loggers. As a means of providing backup to the electronically obtained water levels, water level measurements will be obtained manually using a water level meter. The pumping rate should be measured and adjusted before starting each round of water level measurements so that the water levels reflect the proper pumping rate. After the water level has stopped oscillating from any change in the pumping rate, the water level in the pumping well should be measured and recorded. Water levels can then be measured in the monitoring wells. Water level measurements and pumping rates should be recorded on field data sheets with any appropriate comments. The water levels will be plotted in the field as the test progresses on semi-logarithmic graph paper. The pump will be turned off after the drawdown in the monitoring wells has remained constant for a long enough period of time to establish a trend. This could be after 24 hours for confined aquifer tests and after 72 hours for water table aquifer tests.

4.4 Recovery Period

The water levels in the test well and monitoring wells will be collected at a logarithmic frequency after the pump has been turned off. The water level in each well will be recorded on field data sheets and on semi-logarithmic graph paper to monitor the recovery period. Water levels will be collected until 90 percent of the drawdown has recovered.

MEMO

Date: March 29, 2001

To: Doug Mellema, USACE

From: Dan Samela, Stone and Webster

Re: Anticipated Schedule for Pump Test Well Installation, Development, Testing and Abandonment

Test Well Installation and Development

April 3 - Mobilize driller, Install overburden pilot boring at test well location
April 4 - Install overburden test well
April 5 - Develop and assess suitability of overburden test well
April 6 - Commence installation and development of overburden test observation (micro)wells (8) by geoprobe
April 16 - Mobilize driller to install bedrock test well. Set casing.
April 18 - Complete install of bedrock test well
April 19 - Develop bedrock test well, assess suitability of well for pump test.
April 20 - Begin install of bedrock observation wells (8 or 9)
May 11 - Complete overburden and bedrock well installation and development

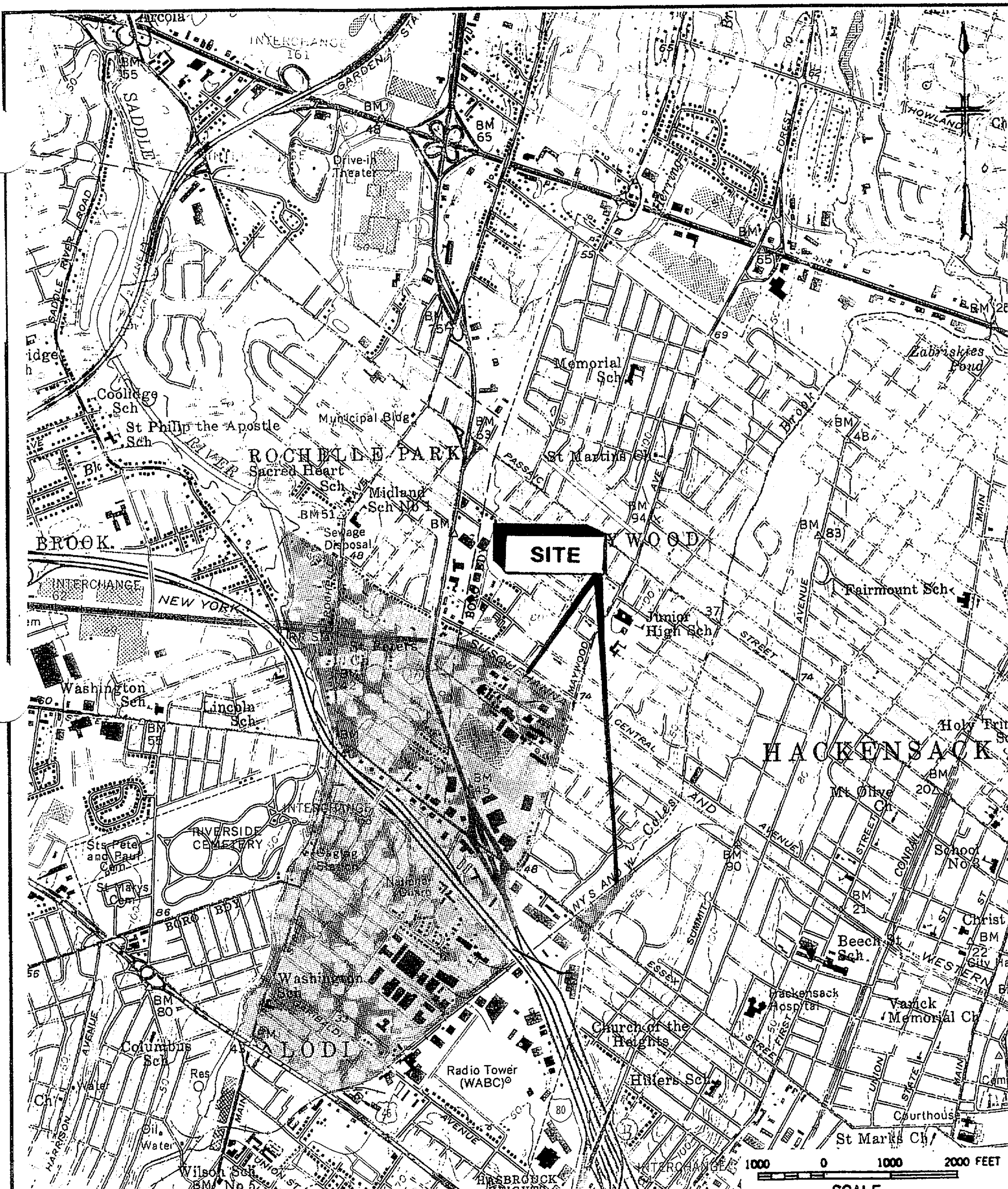
Aquifer Testing

May 22 - Perform step drawdown test on overburden test well
May 24 - Perform step drawdown test on bedrock test well

June 4 - Start of Overburden 72 hour pump test
June 18 - Start of Bedrock 72 hour pump test
June 25 - Complete 72 hour overburden and bedrock aquifer pump testing

Well Abandonment

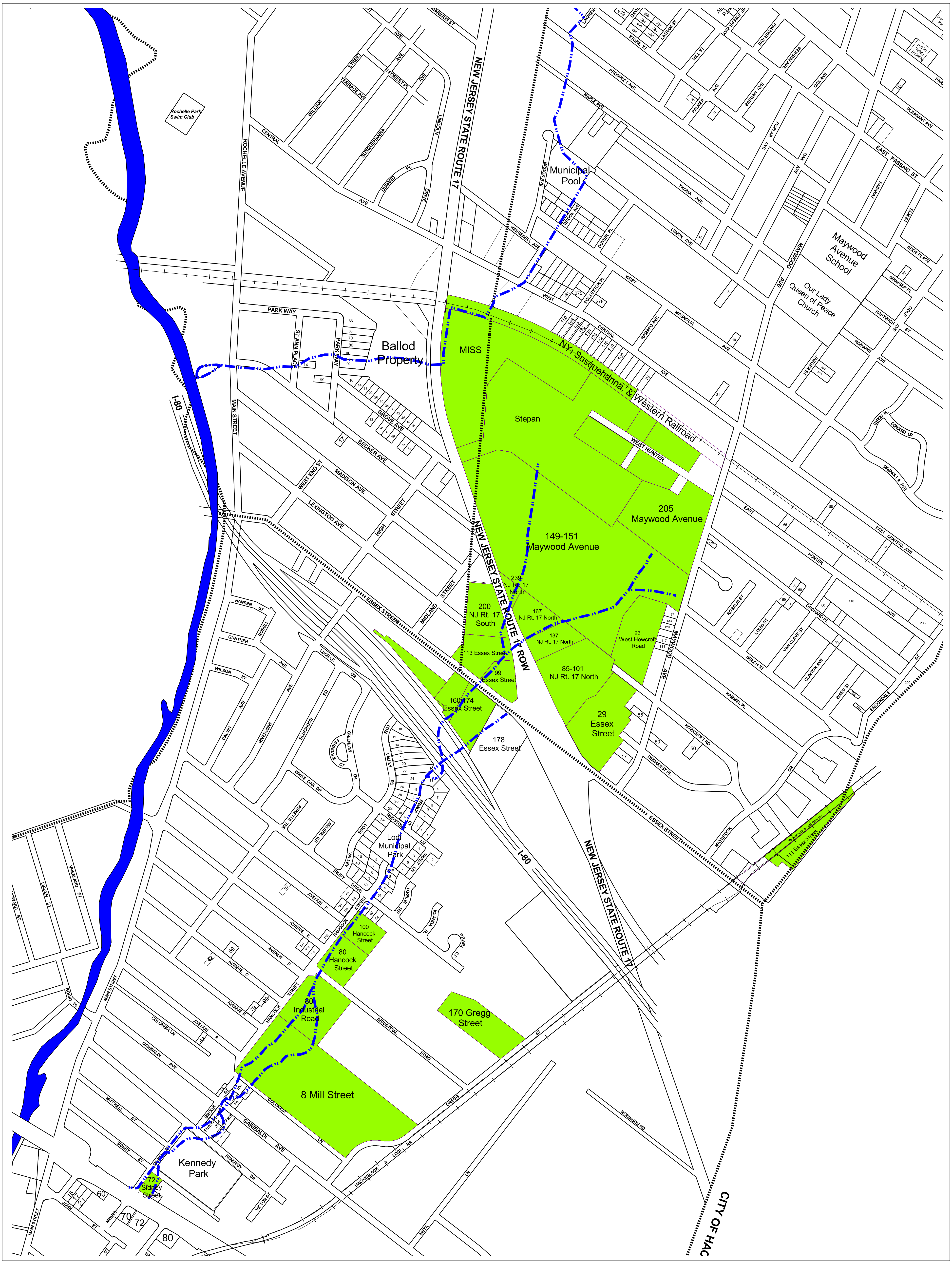
July 16 - Abandon (completely grout) selected bedrock wells, grout other bedrock wells to maximum 25 feet open borehole length. Several bedrock wells may be retained for water level measurements or sampling. Also abandon (by removal and grouting) overburden microwells, retain overburden test well and possibly one or two microwells for water level measurements and/or sampling.



SOURCE: HACKENSACK, NJ USGS QUADRANGLE DATED 1955, PHOTOREVISED 1981

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS NEW YORK DISTRICT US ARMY CORPS OF ENGINEERS FUSRAP FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM	STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES Prepared by: MALCOLM PIRNIE File Name:	SITE MAP GWRI REMEDIAL INVESTIGATION REPORT FUSRAP MAYWOOD SUPERFUND SITE MAYWOOD – LODI, NEW JERSEY	Contract Number: DACW41-98-R-0034 Job Number 08575 WAD# 1 WBS# 14 Figure Number: FIGURE 1-1

FUSRAP MAYWOOD CHEMICAL COMPANY ADDITIONAL AREAS OF INTEREST



Phase II Properties

Figure 1-2
Location of FMSS Properties

N W E S

0 600 1200 Feet

Note: The location and status of the vicinity properties shown on this map are for general reference only. The USACE is reviewing historical archives to confirm the accuracy of the property locations and status depicted on the map. If you have specific questions about a particular property, please contact the USACE Public Information Center at 75A West Pleasant Avenue, Maywood, New Jersey or call 201-843-7466. Or, visit the FUSRAP Maywood Chemical Company Superfund Site website at <www.fusrapmaywood.com>.

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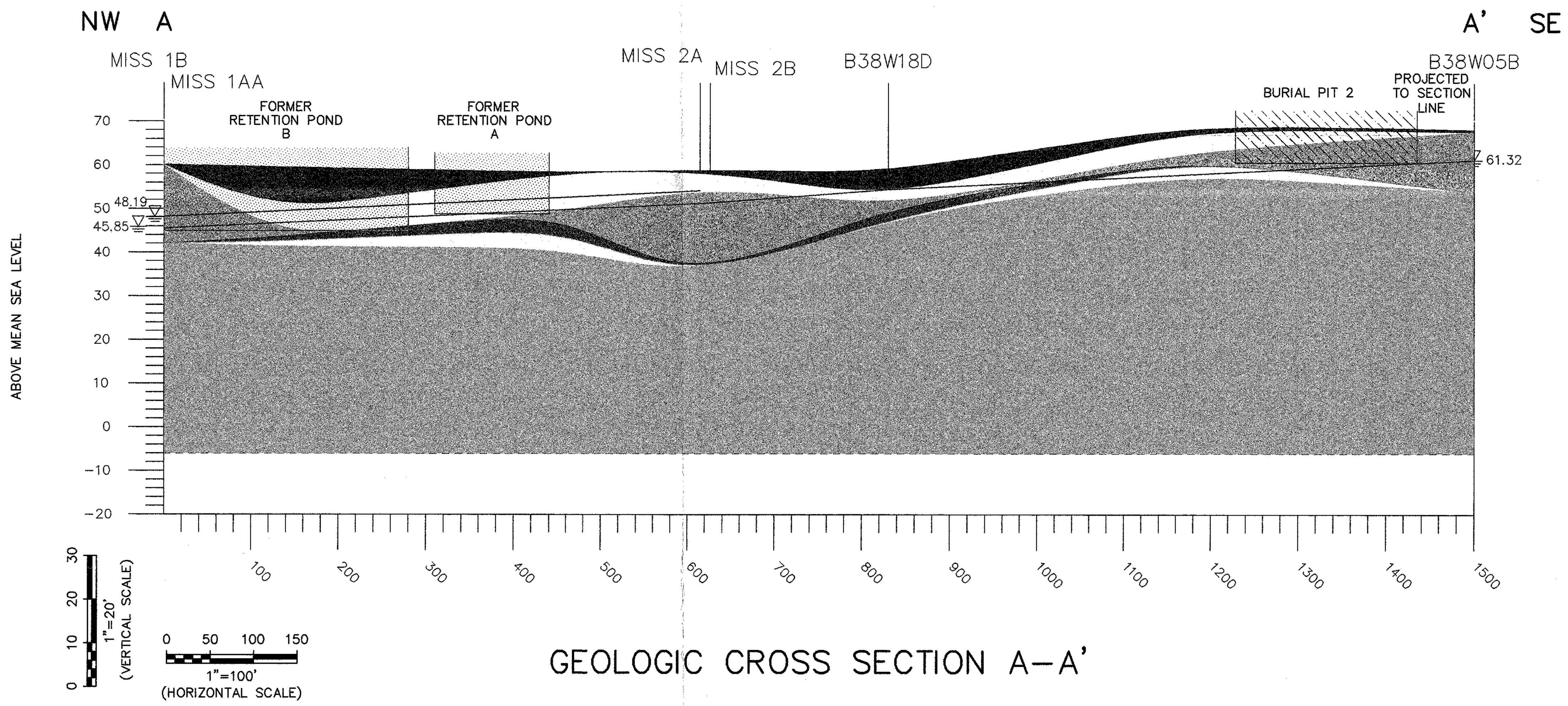
FUSRAP Maywood Superfund Site

Stone & Webster

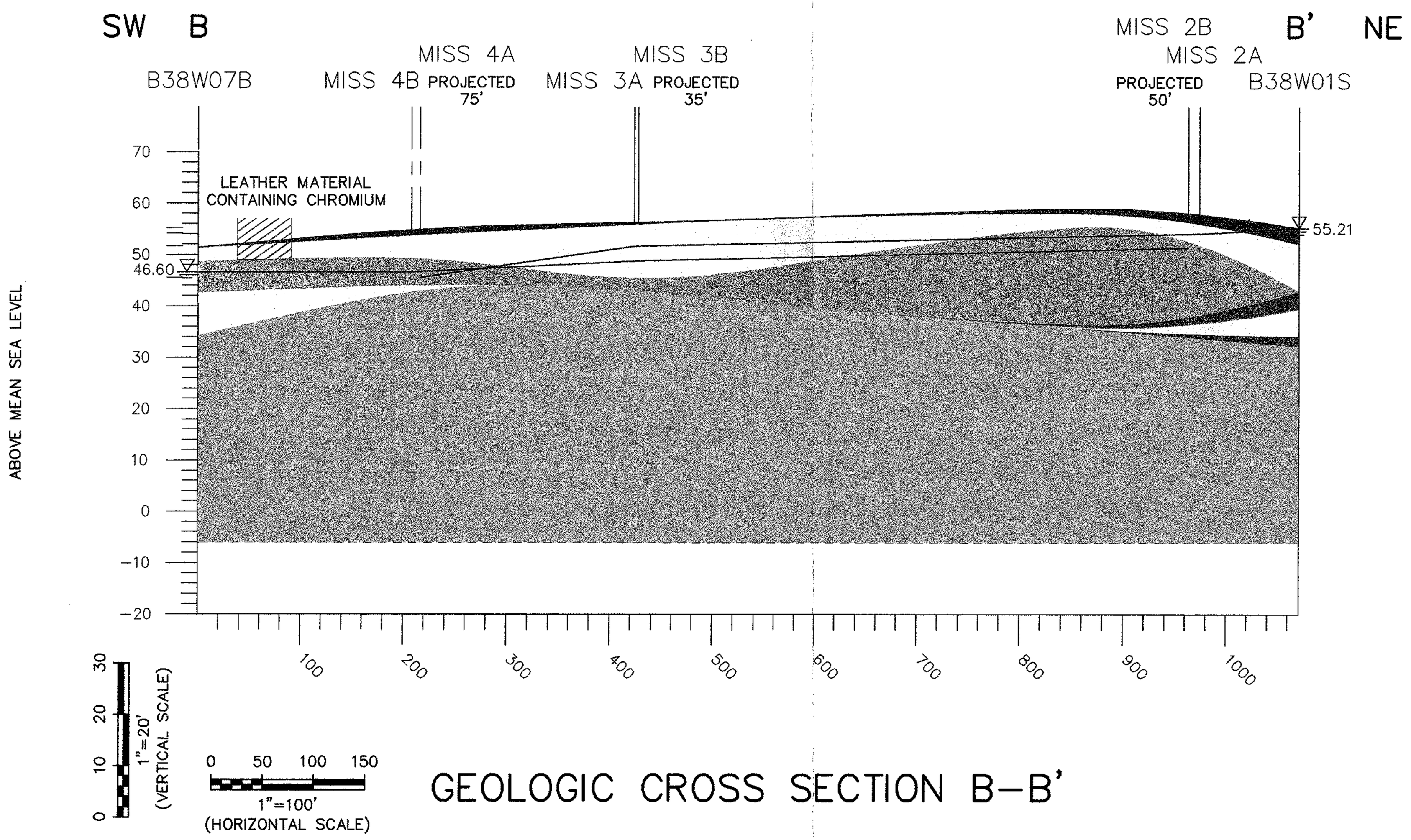
\\BOSFS01\P:/Maywood/Tas0205/GIS/0205.apr - Additional Interest - January 24, 2001



GEOLOGIC CROSS SECTION A–A'

LEGEND

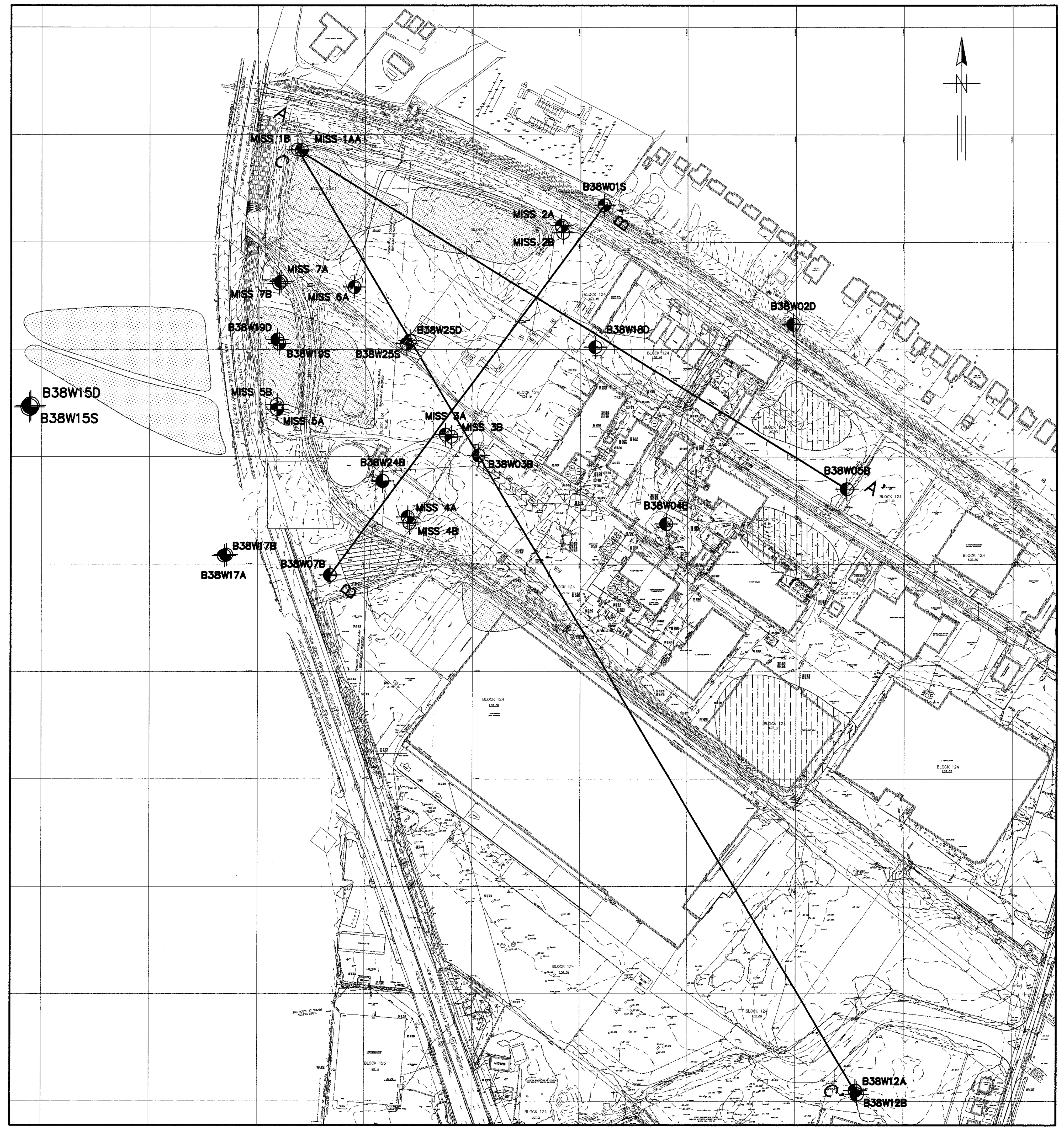
- FILL
- SAND
- SILTY SAND, SAND CLAY MIX
- SILT
- GRAVEL
- CLAY
- PASSAIC FORMATION (SILTSTONE/SANDSTONE)



GEOLOGIC CROSS SECTION B–B'

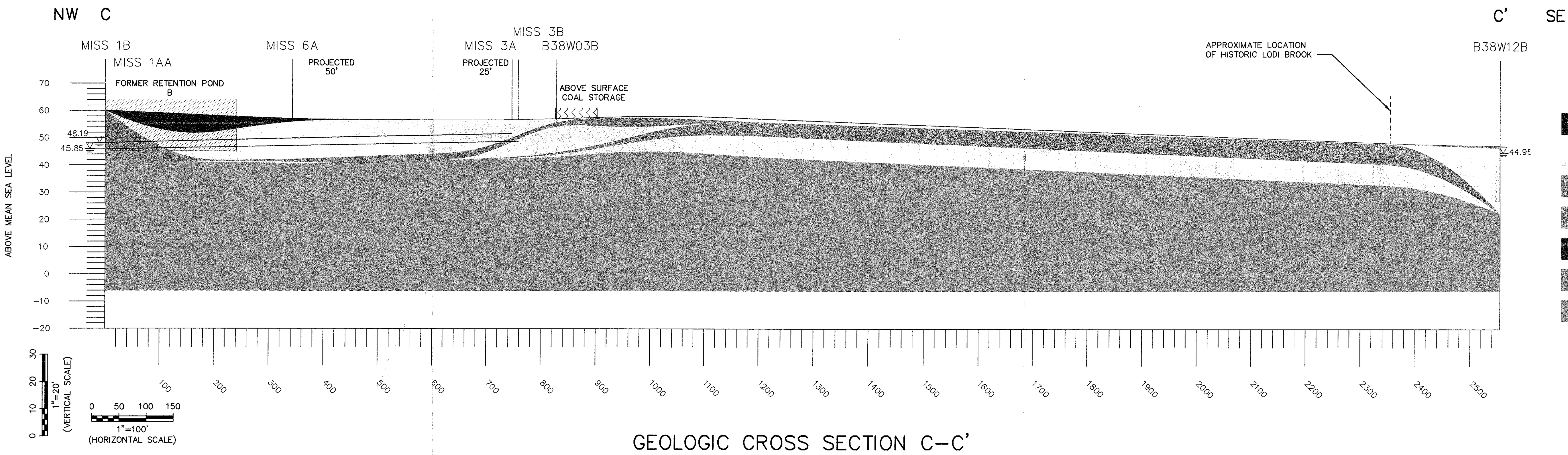
LEGEND

- FILL
- SAND
- SILTY SAND, SAND CLAY MIX
- SILT
- GRAVEL
- CLAY
- PASSAIC FORMATION (SILTSTONE/SANDSTONE)



LOCATION MAP

1"=150'



GEOLOGIC CROSS SECTION C–C'

LEGEND

- FILL
- SAND
- SILTY SAND, SAND CLAY MIX
- SILT
- GRAVEL
- CLAY
- PASSAIC FORMATION (SILTSTONE/SANDSTONE)

LEGEND

- BURIAL PITS
- COAL STORAGE
- APPROXIMATE AREAS OF LEATHER MATERIAL CONTAINING CHROMIUM
- FORMER RETENTION POND
- FORMER RETENTION POND (REMEDIATED)
- GROUNDWATER ELEVATION (3/27/00)

NOTES:

1. THIS SURVEY SHOWS CONDITIONS AS OF OCTOBER 1999 BASED ON AERIAL MAPPING PREPARED BY GEOD CORP. AND GROUND SURVEY BY GARDEN STATE ENGINEERING SURVEYING AND PLANNING.
2. VERTICAL DATUM IS REFERENCED TO NGVD 1929.
3. HORIZONTAL DATUM IS REFERENCED TO NEW JERSEY STATE PLANE COORDINATE SYSTEM NAD 1927.
4. LOCATION OF HISTORIC LODI BROOK SHOWN ON THIS MAP IS APPROXIMATE ONLY. IT HAS BEEN TRANSFERRED FROM HISTORIC RECORDS THAT UTILIZED BASE MAPPING THAT DOES NOT CORRELATE WELL WITH BASE MAPPING SHOWN ON THIS SHEET.

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS NEW YORK DISTRICT US ARMY CORPS OF ENGINEERS FUSRAP FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM	STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES Prepared by: MALCOLM PIRNIE Reviewed by: Date: Drawn by: LGM Date: 7/2000 File Name: GEOSECT	SITE SPECIFIC GEOLOGIC CROSS SECTIONS GROUNDWATER REMEDIAL INVESTIGATION PHASE I – INTERIM REPORT FUSRAP MAYWOOD SUPERFUND SITE MAYWOOD, LODI, AND ROCHELLE PARK, NEW JERSEY	Contract Number: DACW41-98-R-0034 Job Number 08575 WAD# 3 WBS# 10 Figure Number: 1-3

SYNOPTIC GROUNDWATER LEVEL MEASUREMENTS (SHALLOW BEDROCK) MARCH 27, 2000

Well ID	G.W. Elev. FT MSL
B38W02D	53.02
B38W03B	49.52
B38W04B	56.95
B38W05B	61.32
B38W07B	46.60
B38W17B	45.20
B38W19D	45.08
B38W24D	46.98
B38W25D	51.86

LEGEND

50 — GROUNDWATER CONTOUR

BEDROCK WELL

GROUNDWATER FLOW DIRECTION

NOTES:

1. THIS SURVEY SHOWS CONDITIONS AS OF OCTOBER 1999 BASED ON AERIAL MAPPING PREPARED BY GEOD CORP. AND GROUND SURVEY BY GARDEN STATE ENGINEERING SURVEYING AND PLANNING.
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0 50 100 150

1"=100'

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
NEW YORK DISTRICT

US ARMY CORPS OF ENGINEERS
FUSRAP
FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES

Prepared by: MALCOLM PIRNIE
Reviewed by:
Date:
Drawn by: LGM
Date: 8/2000
File Name: sh-bdrck

GROUNDWATER CONTOUR MAP SHALLOW BEDROCK - 03/27/00

GROUNDWATER REMEDIAL INVESTIGATION PHASE I - INTERIM REPORT
FUSRAP MAYWOOD SUPERFUND SITE
MAYWOOD, LODI, AND ROCHELLE PARK, NEW JERSEY

Contract Number: DACW41-98-R-0034
Job Number 08575
WAD# 3
WBS# 10
Figure Number: 1-4

SYNOPTIC GROUNDWATER LEVEL MEASUREMENTS
(DEEP AND SHALLOW BEDR0CK)
MARCH 27, 2000

Well ID	G.W. Elev.
	FT MSL
B38W02D	53.02
B38W03B	49.52
B38W04B	56.95
B38W05B	61.32
B38W07B	46.60
B38W12B	44.96
B38W17B	45.20
B38W18D	54.44
B38W19D	45.08
B38W24D	46.98
B38W25D	51.86
MISS 1B	45.85
MISS 2B	51.14
MISS 3B	48.84
MISS 4B	46.66
MISS 5B	45.10
MISS 7B	45.59

LEGEND

50 GROUNDWATER CONTOUR

BEDROCK WELL

OPEN HOLE WELL

GROUNDWATER FLOW DIRECTION

NOTES:

1. THIS SURVEY SHOWS CONDITIONS AS OF OCTOBER 1999 BASED ON AERIAL MAPPING PREPARED BY GEOD CORP. AND GROUND SURVEY BY GARDEN STATE ENGINEERING SURVEYING AND PLANNING.
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0 50 100 150
1"=100'

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
NEW YORK DISTRICT
US ARMY CORPS OF ENGINEERS
FUSRAP
FORMERLY UTILIZED SITES
REMEDIAL ACTION PROGRAM

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES
Prepared by: MALCOLM PIRNIE
Reviewed by: Date:
Drawn by: LGM Date: 8/2000
File Name: COMPOSIT

GROUNDWATER CONTOUR MAP
SHALLOW & DEEP BEDROCK–3/27/00
GROUNDWATER REMEDIAL INVESTIGATION
PHASE I – INTERIM REPORT
FUSRAP MAYWOOD SUPERFUND SITE
MAYWOOD, LODI, AND
ROCHELLE PARK, NEW JERSEY

Contract Number: DACW41–98–R–0034
Job Number 08575
WAD# 3
WBS# 10
Figure Number: 1-5

SYNOPTIC GROUNDWATER LEVEL MEASUREMENTS
(DEEP BEDROCK)
MARCH 27, 2000

Well ID	G.W. Elev. FT MSL
MISS 1B	45.85
MISS 2B	51.14
MISS 3B	48.84
MISS 4B	46.66
MISS 5B	45.10
MISS 7B	45.59
B38W18D	54.44

LEGEND

50 GROUNDWATER CONTOUR

OPEN HOLE WELL

GROUNDWATER FLOW DIRECTION

NOTES:

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0 50 100 150
1"=100'

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REMEDIAL ACTION PROGRAM

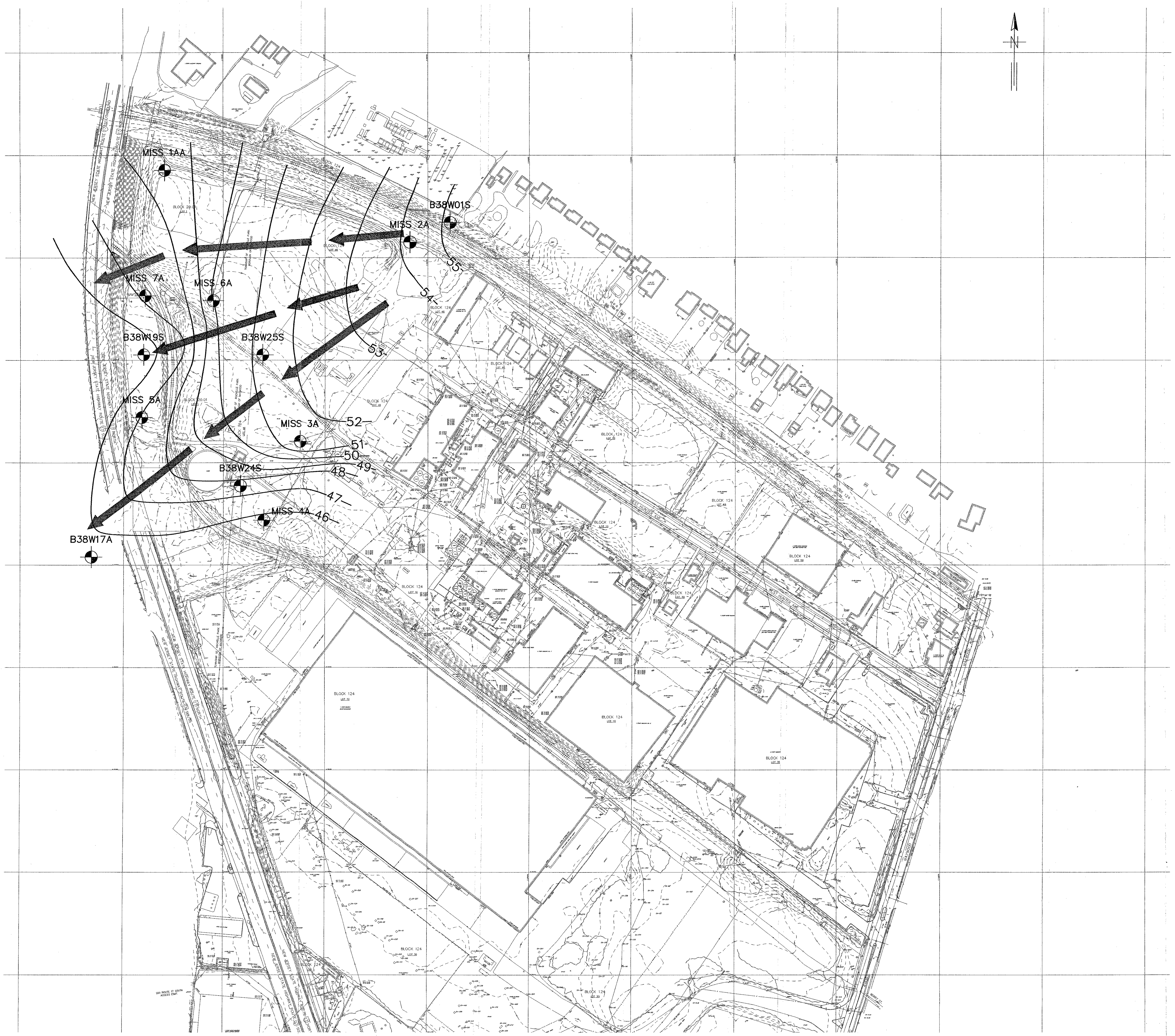
STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES

Prepared by: MALCOLM PIRNIE
Reviewed by: Date:
Drawn by: LGM Date: 8/2000
File Name: dp-bdrck

GROUNDWATER CONTOUR MAP
DEEP BEDROCK - 03/27/00

GROUNDWATER REMEDIAL INVESTIGATION
PHASE I - INTERIM REPORT
FUSRAP MAYWOOD SUPERFUND SITE
MAYWOOD, LODI, AND
ROCHELLE PARK, NEW JERSEY

Contract Number: DACW41-98-R-0034
Job Number 08575
WAD# 3
WBS# 10
Figure Number: 1-6



SYNOPTIC GROUNDWATER LEVEL MEASUREMENTS
(OVERBURDEN)
MARCH 27, 2000

Well ID	G.W. Elev. FT MSL
B38W01S	55.21
B38W12A	44.77
B38W17A	45.28
B38W19S	45.17
B38W24S	47.39
B38W25S	51.48
MISS 1AA	48.19
MISS 2A	54.14
MISS 3A	51.67
MISS 4A	45.70
MISS 5A	47.22
MISS 6A	49.99
MISS 7A	47.45

LEGEND

46 GROUNDWATER CONTOUR

OVERBURDEN WELL

GROUNDWATER FLOW DIRECTION

NOTES:

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0 50 100 150
1"=100'

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REMEDIAL ACTION PROGRAM

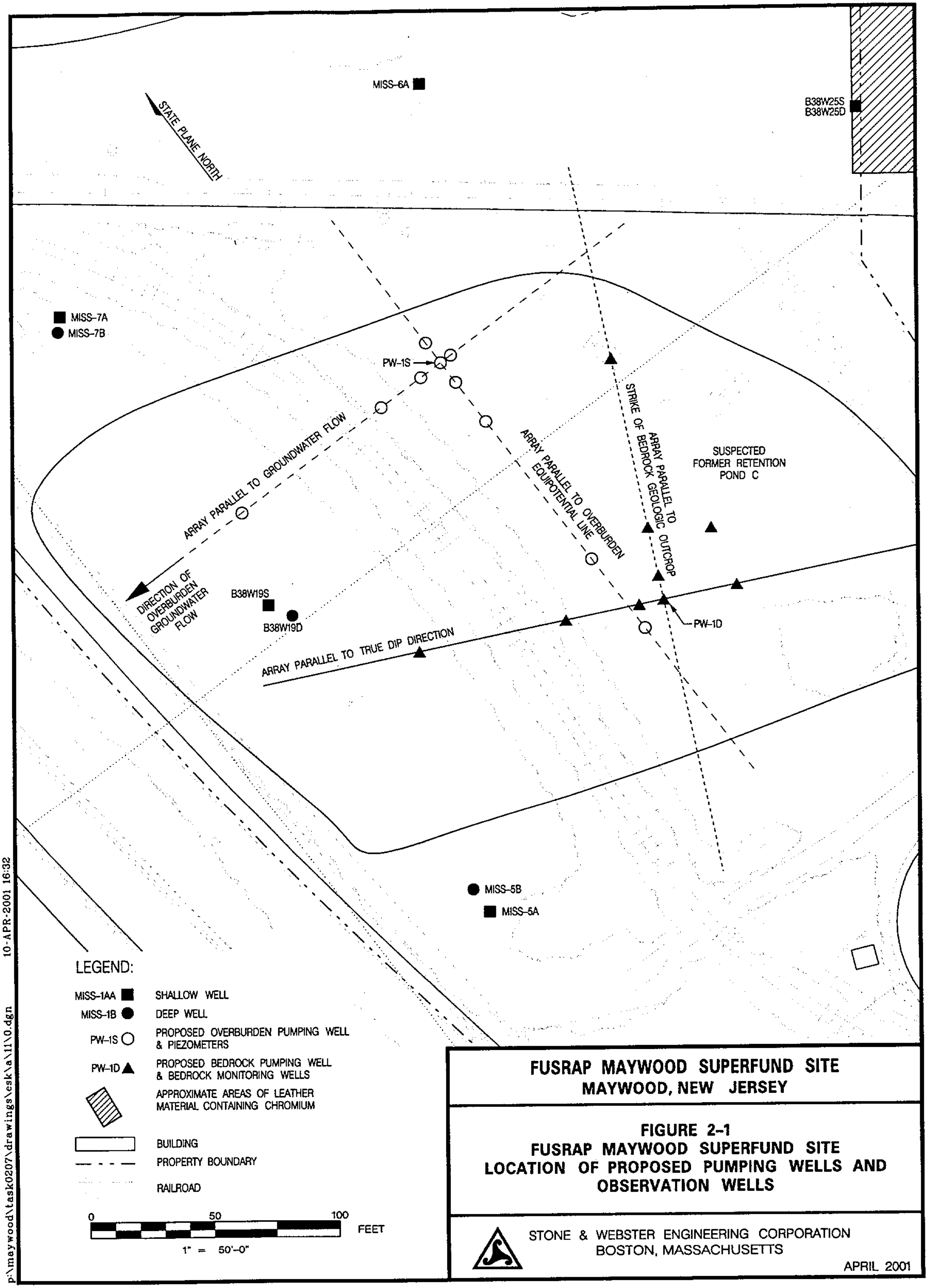
STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES

Prepared by: MALCOLM PIRNIE
Reviewed by:
Date:
Drawn by: LGM
Date: 8/2000
File Name: OVRBRDN

GROUNDWATER CONTOUR MAP
OVERBURDEN - 03/27/00

GROUNDWATER REMEDIAL INVESTIGATION
PHASE I - INTERIM REPORT
FUSRAP MAYWOOD SUPERFUND SITE
MAYWOOD, LODI, AND
ROCHELLE PARK, NEW JERSEY

Contract Number: DACW41-98-R-0034
Job Number 08575
WAD# 3
WBS# 10
Figure Number: 1-7



FUSRAP MAYWOOD SUPERFUND SITE
MAYWOOD, NEW JERSEY

FIGURE 2-1
FUSRAP MAYWOOD SUPERFUND SITE
LOCATION OF PROPOSED PUMPING WELLS AND OBSERVATION WELLS

STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASSACHUSETTS

APRIL 2001

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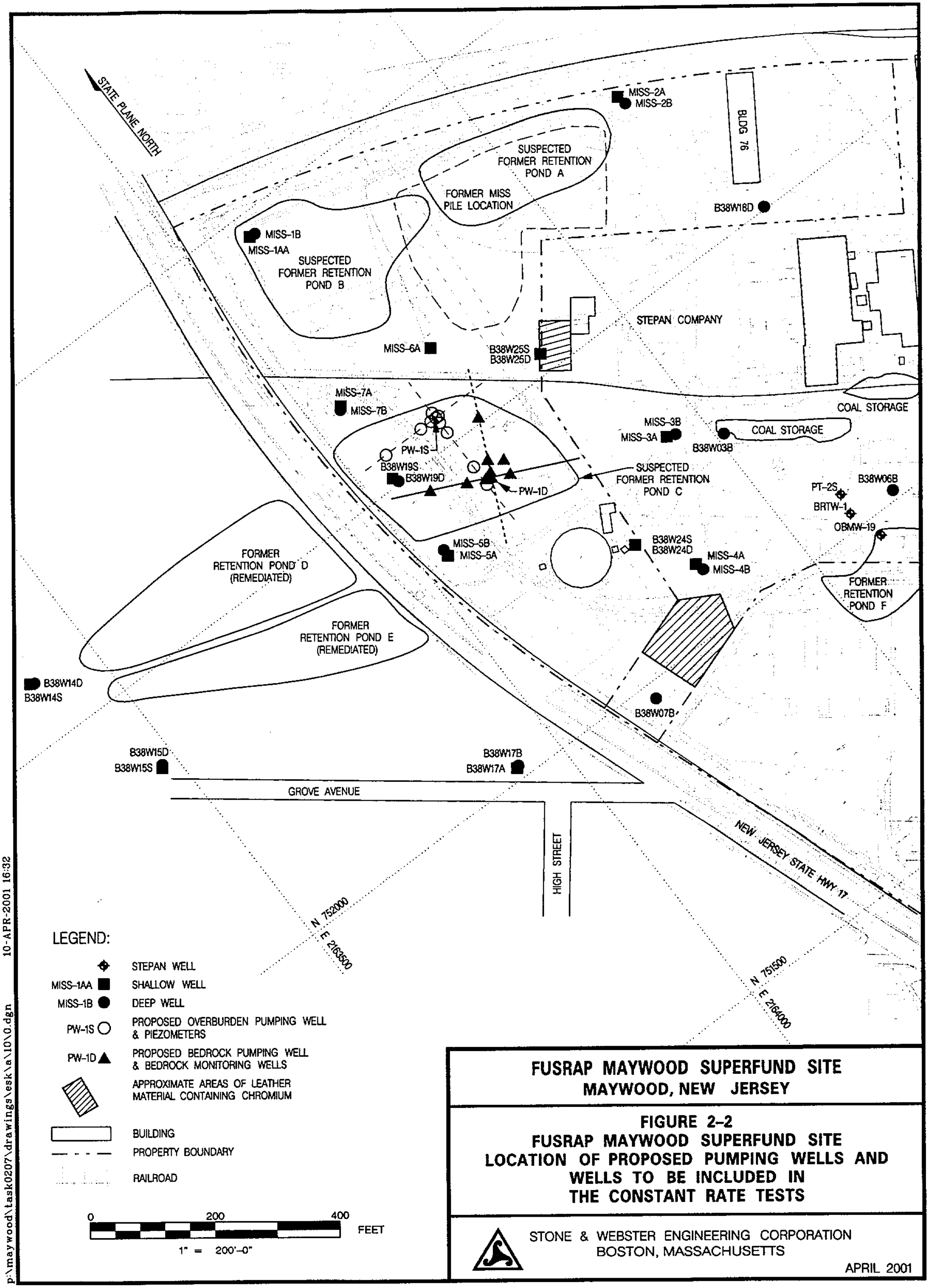

FUSRAP MAYWOOD SUPERFUND SITE
MAYWOOD, NEW JERSEY

FIGURE 2-2
FUSRAP MAYWOOD SUPERFUND SITE
LOCATION OF PROPOSED PUMPING WELLS AND WELLS TO BE INCLUDED IN THE CONSTANT RATE TESTS

STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASSACHUSETTS

APRIL 2001

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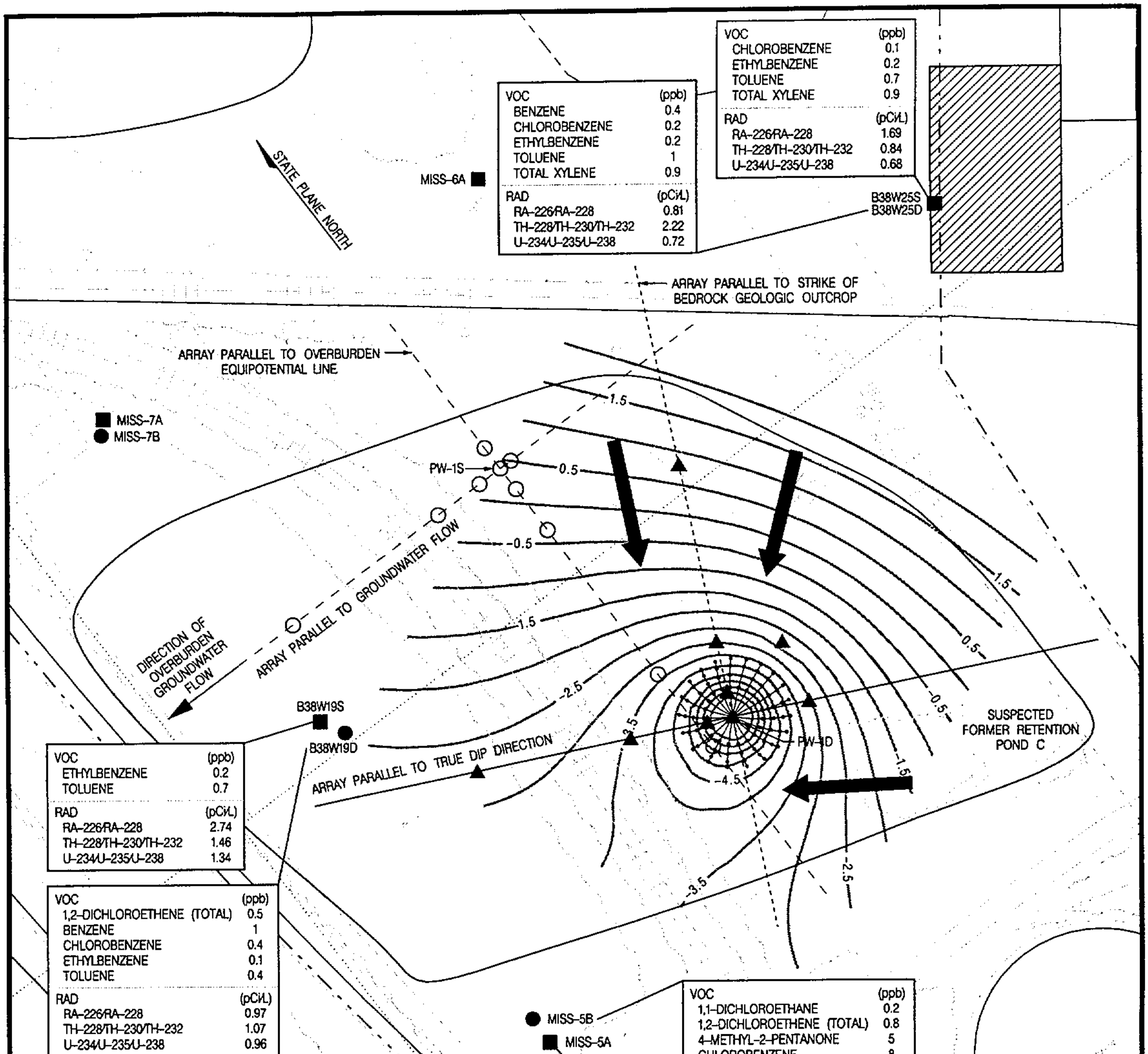

LEGEND:

VOCs	IN MICROGRAMS PER LITER/PARTS PER BILLION
Rad	IN PICOCURIES PER LITER (pCi/L)
MISS-1AA ■	SHALLOW WELL
MISS-1B ●	DEEP WELL
PW-1S ○	PROPOSED OVERBURDEN PUMPING WELL & PIEZOMETERS
PW-1D ▲	PROPOSED BEDROCK PUMPING WELL & BEDROCK MONITORING WELLS
	EXTENT OF CAPTURE ZONE AFTER 72 HOURS
	APPROXIMATE AREAS OF LEATHER MATERIAL CONTAINING CHROMIUM
	GROUNDWATER FLOW DIRECTION
	BUILDING
	PROPERTY BOUNDARY
	RAILROAD

NOTE:

EQUIPOTENTIAL LINES REFERENCED TO AN ARBITRARY DATUM ORIGINATING AT THE PUMPING WELL.

0 60 120 FEET

1" = 60'-0"

FUSRAP MAYWOOD SUPERFUND SITE
MAYWOOD, NEW JERSEY

FIGURE 2-3
VOC AND RADIOLOGICAL PARAMETERS PRESENT IN MONITORING WELLS LOCATED WITHIN 200 FEET OF THE PROPOSED BEDROCK PUMPING WELL
NOVEMBER 2000

STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASSACHUSETTS

APRIL 2001

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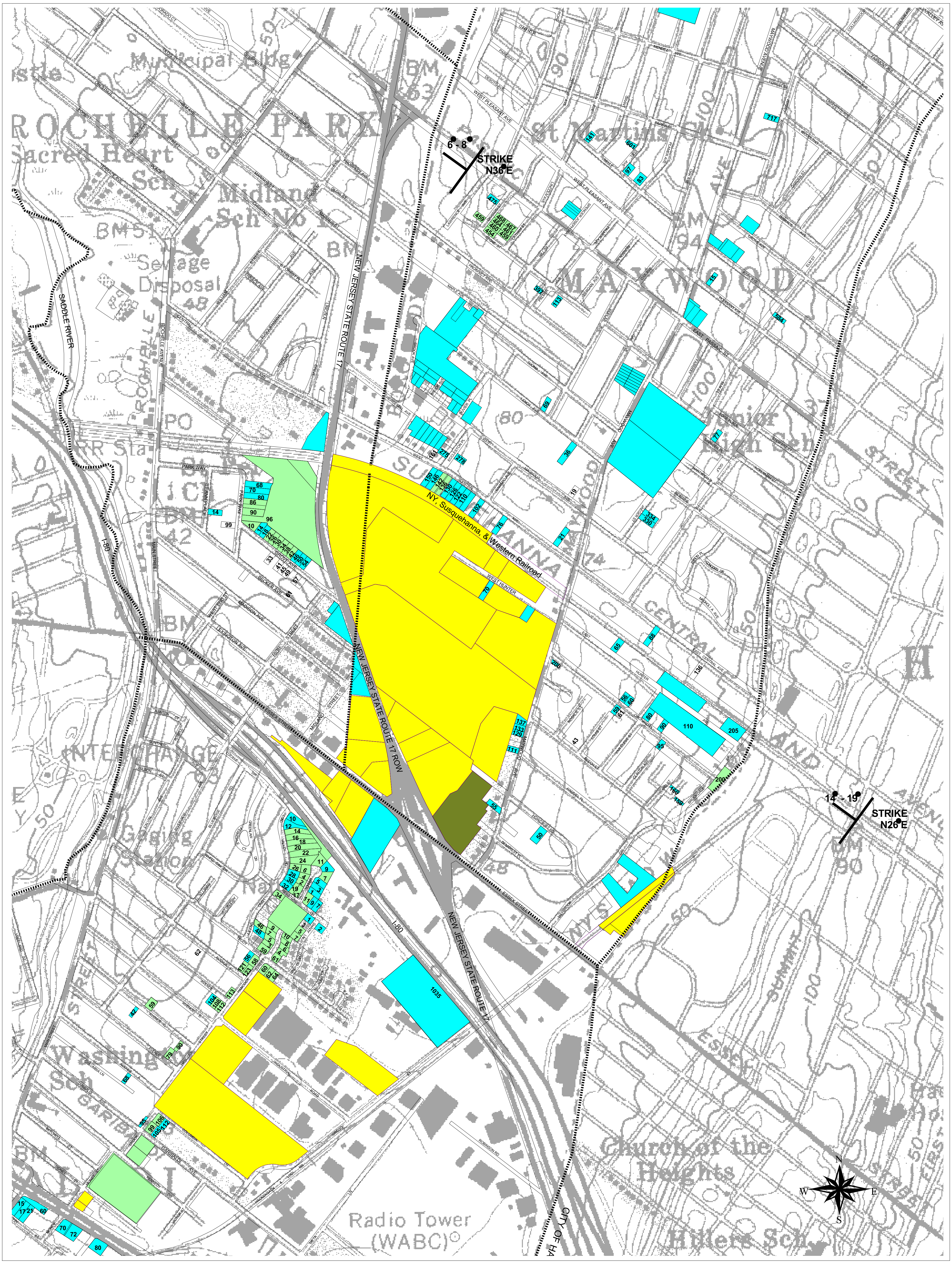

Figure 2-4
Location of Mapped Bedrock Outcrops within the FMSS Properties

14 - 19 N 26°E

Strike and Dip of Bedrock

Phase I Properties
- *Remediated*
- *Surveyed - Not contaminated*

Phase II Properties
- *Scheduled for remediation*
- *Surveyed - Not contaminated*

US Army Corps of Engineers®

FUSRAP Maywood Superfund Site

Stone & Webster

0 700 1400 Feet

Note: The location and status of the vicinity properties shown on this map are for general reference only. The USACE is reviewing historical archives to confirm the accuracy of the property locations and status depicted on the map. If you have specific questions about a particular property, please contact the USACE Public Information Center at 75A West Pleasant Avenue, Maywood, New Jersey or call 201-843-7466. Or, visit the FUSRAP Maywood Chemical Company Superfund Site website at <www.fusrapmaywood.com>.

Dip Plot & Strike Azimuth - April 11, 2001

TABLE 1-1

DEPTH TO GROUNDWATER, GROUNDWATER ELEVATIONS AND WELL GEOMETRY FOR OVERBURDEN MONITORING WELLS
JUNE 1999 THROUGH JUNE 2000

MAYWOOD FUSRAP SUPERFUND SITE
MAYWOOD, NJ

	Spatial Coordinates		Well Geometry								6/12/00 - Environmental Monitoring Program			3/27/00 - Groundwater Remedial Investigation Program		
Well Name	Northing	Easting	Elevation TOR (ft MSL)	Ground Surface Elevation (ft MSL)	Total Well Depth (ft BGS)	Screen Interval (ft BGS)		Screen Interval (ft MSL)		Sump Length (ft)	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)
MISS01AA	752,963.64	2,164,101.98	62.7	60.50	19.0	13.0	18.0	43.5	41.3	1.0	12.16	14.36	48.34	12.31	14.51	48.19
MISS02A	752,788.00	2,164,706.13	61.47	60.56	18.9	6.9	16.9	48.1	47.2	2.0	7.74	8.65	52.82	6.42	7.33	54.14
MISS03A	752,302.00	2,164,437.77	58.52	56.56	12.7	6.7	11.7	49.9	44.9	1.0	5.44	7.40	51.12	4.89	6.85	51.67
MISS04A	752,109.73	2,164,349.46	57.17	55.36	9.7	4.7	9.7	50.7	45.7	0.0	6.64	8.45	48.72	9.66	11.47	45.70
MISS05A	752,360.40	2,164,044.20	58.65	57.86	14.8	10.7	14.6	42.8	42.0	0.2	11.45	12.24	46.41	10.64	11.43	47.22
MISS06A	752,645.21	2,164,224.78	58.26	57.07	15.2	7.2	13.2	44.5	43.3	2.0	8.58	9.77	48.49	7.08	8.27	49.99
MISS07A	752,657.57	2,164,053.10	55.60	53.52	9.6	4.6	9.6	48.9	43.92	0.0	6.32	8.40	47.20	6.07	8.15	47.45
B38W01S	752,836.02	2,164,805.24	60.72	57.55	23.0	17.0	22.0	51.6	48.4	1.0	2.49	5.66	55.06	2.34	5.51	55.21
B38W12A	750,774.61	2,165,389.50	50.1	47.23	14.8	7.4	12.4	39.6	36.8	2.4	2.57	5.44	44.66	2.46	5.33	44.77
B38W14S	752,600.98	2,163,384.82	43.89	44.18	14.0	8.0	13.0	38.6	39.0	1.0	4.74	4.45	39.44	NG	NG	N/A
B38W15S	752,365.46	2,163,471.15	45.70	46.24	16.5	10.5	15.5	35.7	30.7	1.0	5.84	5.30	40.40	NG	NG	N/A
B38W17A	752,019.80	2,163,922.90	53.24	50.70	14.1	7.6	12.6	41.3	38.7	1.5	5.72	8.26	44.98	5.42	7.96	45.28
B38W19S	752,513.62	2,164,049.13	59.91	57.48	15.8	12.9	14.9	42.2	39.7	0.9	12.59	15.02	44.89	12.31	14.74	45.17
B38W24S	752,193.57	2,164,291.43	55.04	55.38	15.6	10.4	15.2	43.5	43.9	0.4	9.36	9.02	46.02	7.99	7.65	47.39
B38W25S	752,512.97	2,164,346.37	57.44	55.67	12.7	6.7	11.7	46.3	44.6	1.0	4.15	5.92	51.52	4.19	5.96	51.48

Min. GW Elv. (ft MSL)		39.44			44.77
Max. GW Elv. (ft MSL)		55.06			55.21

Legend

TOR - Top of Riser
DTW - Depth to Water
BGS - Below Ground Surface
ft - feet
MSL - Mean Sea Level
NG - Not Gauged
NA - Not Applicable

TABLE 1-1

DEPTH TO GROUNDWATER, GROUNDWATER ELEVATIONS AND WELL GEOMETRY FOR OVERBURDEN MONITORING WELLS
JUNE 1999 THROUGH JUNE 2000

MAYWOOD FUSRAP SUPERFUND SITE
MAYWOOD, NJ

	2/22-2/24/00 - Groundwater Remedial investigation Program			1/19/00 - Environmental Monitoring Program			8/10-8/12/1999 - Environmental Monitoring Program			6/22/1999 - Environmental Monitoring Program					
Well Name	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)	Minimum Water Level Elevation (ft MSL) - Synoptic Gauging Year	Maximum Water Level Elevation (ft MSL) - Synoptic Gauging Year	Water Level Fluctuation (ft)
MISS01AA	13.27	15.47	47.23	NG	NG	NA	17.01	19.21	43.49	15.05	17.25	45.45	43.49	48.34	4.85
MISS02A	5.61	6.52	54.95	7.39	8.3	53.17	12.47	13.38	48.09	9.49	10.4	51.07	48.09	54.95	6.86
MISS03A	5.19	7.15	51.37	5.44	7.4	51.12	Dry	Dry	Dry	7.72	9.68	48.84	48.84	51.67	2.83
MISS04A	5.24	7.05	50.12	6.01	7.82	49.35	Dry	Dry	Dry	8.59	10.4	46.77	45.70	50.12	4.42
MISS05A	10.86	11.65	47.00	9.53	10.32	48.33	15.08	15.87	42.78	13.26	14.05	44.6	42.78	48.33	5.55
MISS06A	7.44	8.63	49.63	9.14	10.33	47.93	12.61	13.8	44.46	10.51	11.7	46.56	44.46	49.99	5.53
MISS07A	5.18	7.26	48.34	6.42	8.50	47.10	7.47	9.55	46.05	7.17	9.25	46.35	46.05	48.34	2.29
B38W01S	2.14	5.31	55.41	2.69	5.86	54.86	5.94	9.11	51.61	3.74	6.91	53.81	51.61	55.41	3.80
B38W12A	2.44	5.31	44.79	2.91	5.78	44.32	7.59	10.46	39.64	4.44	7.31	42.79	39.64	44.79	5.15
B38W14S	NG	NG	NA	NG	NG	NA	5.61	5.21	38.68	NG	NG	NA	38.68	39.44	0.76
B38W15S	NG	NG	NA	NG	NG	NA	NG	NG	NA	NG	NG	NA	40.40	40.40	0.00
B38W17A	5.64	8.18	45.06	6.11	8.65	44.59	9.45	11.99	41.25	7.44	9.98	43.26	41.25	45.28	4.03
B38W19S	13.51	15.94	43.97	12.87	15.3	44.61	15.31	17.74	42.17	13.95	16.38	43.53	42.17	45.17	3.00
B38W24S	9.11	8.77	46.27	9.49	9.15	45.89	11.84	11.5	43.54	10.69	10.35	44.69	43.54	47.39	3.85
B38W25S	4.73	6.50	50.94	5.23	7	50.44	9.33	11.1	46.34	6.36	8.13	49.31	46.34	51.52	5.18

Legend

		43.97			44.32			38.68			42.79
		55.41			54.86			51.61			53.81

TOR - Top of Riser
DTW - Depth to Water
BGS - Below Ground Surface
ft - feet
MSL - Mean Sea Level
NG - Not Gauged
NA - Not Applicable

TABLE 1-2

DEPTH TO GROUNDWATER, GROUNDWATER ELEVATIONS AND WELL GEOMETRY FOR BEDROCK MONITORING WELLS
JUNE1999 THROUGH JUNE 2000

MAYWOOD FUSRAP SUPERFUND SITE
MAYWOOD, NJ

	Spatial Coordinates		Well Geometry										6/12/2000			3/27/00		
Well	Northing	Easting	Elevation TOR (ft MSL)	Ground Surface Elevation (ft MSL)	Total Well Depth (ft BGS)	Screen Interval (ft BGS)		Screen Interval (ft MSL)		Depth to Bedrock (ft BGS)	Elv. Bedrock Surface (ft MSL)	Extent of Well into Rock (ft)	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)
MISS01B	752,964.86	2,164,092.32	61.98	60.42	53.5	23.0	53.5	37.4	6.9	18.0	42.4	35.5	14.21	15.77	46.21	14.57	16.13	45.85
MISS02B	752,771.91	2,164,709.45	61.64	61.15	58.5	28.5	58.5	32.7	2.7	21.5	39.7	37.0	10.28	10.77	50.87	10.01	10.50	51.14
MISS03B	752,296.78	2,164,451.46	57.66	56.78	50.0	20.0	50.0	36.8	6.8	15.0	41.8	35.0	8.02	8.90	48.76	7.94	8.82	48.84
MISS04B	752,096.08	2,164,353.55	56.42	55.38	47.0	17.0	47.0	38.4	8.4	11.5	43.9	35.5	9.01	10.05	46.37	8.72	9.76	46.66
MISS05B	752,371.68	2,164,044.40	59.76	58.09	55.0	25.0	55.0	33.1	3.1	18.0	40.1	37.0	13.23	14.90	44.86	12.99	14.66	45.10
MISS07B	752,652.98	2,164,048.77	55.77	53.99	49.0	19.0	49.0	35.0	5.0	13.0	41.0	36.0	8.44	10.22	45.55	8.40	10.18	45.59
B38W02D	752,558.00	2,165,243.20	67.70	64.75	43.0	37.0	42.0	27.8	22.8	10.5	54.3	31.5	11.67	14.62	53.08	11.73	14.68	53.02
B38W03B	752,253.19	2,164,513.81	58.27	56.93	40.5	29.8	39.5	27.1	17.4	8.6	48.3	30.9	7.51	8.85	49.42	7.41	8.75	49.52
B38W04B	752,093.44	2,164,950.21	65.85	63.02	36.3	22.7	27.7	40.3	35.3	11.9	51.1	15.8	5.87	8.70	57.15	6.07	8.90	56.95
B38W05B	752,175.06	2,165,367.58	71.05	68.18	44.5	22.7	33.0	45.5	35.2	14.4	53.8	18.6	7.33	10.20	60.85	6.86	9.73	61.32
B38W06B	752,016.47	2,164,670.94	54.41	51.70	36.4	15.9	20.9	35.8	30.8	10.9	40.8	10.0	6.69	9.40	45.01	NG	NG	NG
B38W07B	751,974.49	2,164,168.36	54.63	52.25	39.2	18.5	28.8	33.8	23.5	17.2	35.1	11.6	6.22	8.60	46.03	5.65	8.03	46.60
B38W12B	750,766.38	2,165,393.46	49.78	47.53	50.3	34.5	44.9	13.0	2.6	24.9	22.6	20.0	2.59	4.84	44.94	2.57	4.82	44.96
B38W14D	752,597.24	2,163,391.63	43.79	44.16	51.5	46.0	51.5	-1.8	-7.3	20.9	23.3	30.6	4.37	4.00	39.79	NG	NG	N/A
B38W15D	752,369.12	2,163,474.42	45.89	46.28	46.0	40.0	45.0	6.3	1.3	18.0	28.3	27.0	5.06	4.67	41.22	NG	NG	N/A
B38W17B	752,021.78	2,163,927.32	53.28	50.68	44.4	18.7	29.0	32.0	21.7	14.9	35.8	14.1	5.72	8.32	44.96	5.48	8.08	45.20
B38W18D	752,505.39	2,164,783.97	57.85	58.02	41.0	35.0	40.0	23.0	18.0	10.3	47.7	29.7	3.57	3.40	54.45	3.58	3.41	54.44
B38W19D	752,522.83	2,164,045.10	59.98	57.49	47.9	21.7	31.9	35.8	25.6	17.3	40.2	14.6	12.75	15.24	44.74	12.41	14.90	45.08
B38W24D	752,193.57	2,164,291.33	54.91	55.29	28.0	22.0	27.0	33.3	28.3	17.0	38.3	10.0	8.83	8.45	46.46	8.31	7.93	46.98
B38W25D	752,520.38	2,164,353.79	58.24	56.13	27.6	21.6	26.6	34.5	29.5	18.0	38.1	8.6	4.29	6.40	51.84	4.27	6.38	51.86

Minimum GW Elv.	39.79			44.96
Maximum GW Elv.	60.85			61.32

Legend

TOR - Top of Riser
DTW - Depth to Water
BGS - Below Ground Surface
ft - feet
MSL - Mean Sea Level
N/A - Not Applicable
Shaded cells represent well depths typically above 25 ft MSL

TABLE 1-2

DEPTH TO GROUNDWATER, GROUNDWATER ELEVATIONS AND WELL GEOMETRY FOR BEDROCK MONITORING WELLS
JUNE1999 THROUGH JUNE 2000

MAYWOOD FUSRAP SUPERFUND SITE
MAYWOOD, NJ

	2/22-2/24/00			1/19/00			8/10-8/12/1999			6/22/1999					
Well	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)	DTW Below Ground Surface (ft)	DTW Below TOR (ft)	Groundwater Elevation (ft MSL)	Minimum Water Level Elevation (ft MSL) - Synoptic year	Maximum Water Level Elevation (ft MSL) - Synoptic year	Water Level Fluctuation (ft)
MISS01B	12.64	14.20	47.78	14.47	16.03	45.95	17.23	18.79	43.19	15.24	16.80	45.18	43.19	47.78	4.59
MISS02B	9.85	10.34	51.30	10.41	10.90	50.74	13.56	14.05	47.59	11.36	11.85	49.79	47.59	51.30	3.71
MISS03B	7.72	8.60	49.06	8.42	9.30	48.36	11.93	12.81	44.85	9.72	10.60	47.06	44.85	49.06	4.21
MISS04B	8.77	9.81	46.61	NG	NG	N/A	12.32	13.36	43.06	10.50	11.54	44.88	43.06	46.66	3.60
MISS05B	13.11	14.78	44.98	13.53	15.20	44.56	16.28	17.95	41.81	14.65	16.32	43.44	41.81	45.10	3.29
MISS07B	8.55	10.33	45.44	8.77	10.55	45.22	11.37	13.15	42.62	9.72	11.50	44.27	42.62	45.59	2.97
B38W02D	11.32	14.27	53.43	12.60	15.55	52.15	20.46	23.41	44.29	16.05	19.00	48.70	44.29	53.43	9.14
B38W03B	7.54	8.88	49.39	8.00	9.34	48.93	12.02	13.36	44.91	9.31	10.65	47.62	44.91	49.52	4.61
B38W04B	6.17	9.00	56.85	6.87	9.70	56.15	10.63	13.46	52.39	7.65	10.48	55.37	52.39	57.15	4.76
B38W05B	7.41	10.28	60.77	8.60	11.47	59.58	15.08	17.95	53.10	10.53	13.40	57.65	53.10	61.32	8.22
B38W06B	NG	NG	N/A	NG	NG	N/A	NG	NG	NA	NG	NG	NA	45.01	45.01	0.00
B38W07B	6.56	8.94	45.69	6.34	8.72	45.91	10.09	12.47	42.16	8.15	10.53	44.10	42.16	46.60	4.44
B38W12B	2.56	4.81	44.97	3.05	5.30	44.48	7.84	10.09	39.69	4.49	6.74	43.04	39.69	44.97	5.28
B38W14D	NG	NG	N/A	NG	NG	N/A	NG	NG	NA	5.58	5.21	38.58	38.58	39.79	1.21
B38W15D	NG	NG	N/A	NG	NG	N/A	NG	NG	NA	NG	NG	NA	41.22	41.22	0.00
B38W17B	5.75	8.35	44.93	6.15	8.75	44.53	9.39	11.99	41.29	7.40	10.00	43.28	41.29	45.20	3.91
B38W18D	3.11	2.94	54.91	4.12	3.95	53.90	6.37	6.20	51.65	4.47	4.30	53.55	51.65	54.91	3.26
B38W19D	12.67	15.16	44.82	13.09	15.58	44.40	15.99	18.48	41.50	14.07	16.56	43.42	41.50	45.08	3.58
B38W24D	8.48	8.10	46.81	8.93	8.55	46.36	11.88	11.50	43.41	10.28	9.90	45.01	43.41	46.98	3.57
B38W25D	4.57	6.68	51.56	5.79	7.90	50.34	9.44	11.55	46.69	6.24	8.35	49.89	46.69	51.86	5.17
			44.82			44.40			39.69			38.58			
			60.77			59.58			53.10			57.65			

Legend

TOR - Top of Ri
DTW - Depth to
BGS - Below Gr
ft - feet
MSL - Mean Se
N/A - Not Applic
Shaded cells re

TABLE 2-1

DETERMINATION OF PUMPING RATE BASED ON HYDRAULIC PARAMETERS
UNCONFINED AQUIFER

FUSRAP MAYWOOD SUPERFUND SITE
MAYWOOD, NJ

	Given								Determine	
Trial	K	K	Hr	t	Sy	r	s	s'	Q	Q
	cm/sec	ft/day	ft	day	unitless	ft	ft	ft	ft3/day	gpm
1	0.00010	0.283	10.000	0.500	0.150	0.083	5.000	3.750	31.545	0.164
2	0.00010	0.283	10.000	0.500	0.200	0.083	5.000	3.750	29.538	0.153
1	0.00050	1.417	10.000	0.500	0.150	0.083	5.000	3.750	114.272	0.594
2	0.00050	1.417	10.000	0.500	0.200	0.083	5.000	3.750	108.909	0.566
1	0.00100	2.835	10.000	0.500	0.150	0.083	5.000	3.750	204.303	1.061
2	0.00100	2.835	10.000	0.500	0.200	0.083	5.000	3.750	195.689	1.016
Trial	K	K	Hr	t	Sy	r	s	s'	Q	Q
	cm/sec	ft/day	ft	day	unitless	ft	ft	ft	ft3/day	gpm
1	0.00010	0.283	10.000	0.500	0.150	5.000	0.261	0.257	30.000	0.156
2	0.00010	0.283	10.000	0.500	0.150	10.000	0.065	0.065	30.000	0.156
3	0.00010	0.283	10.000	0.500	0.150	25.000	0.010	0.010	30.000	0.156
4	0.00010	0.283	10.000	0.500	0.150	50.000	0.003	0.003	30.000	0.156
5	0.00010	0.283	10.000	0.500	0.150	75.000	0.001	0.001	30.000	0.156
6	0.00010	0.283	10.000	0.500	0.150	100.000	0.001	0.001	30.000	0.156
7	0.00010	0.283	10.000	0.500	0.150	150.000	0.000	0.000	30.000	0.156
1	0.00050	1.417	10.000	0.500	0.150	5.000	0.456	0.446	110.000	0.571
2	0.00050	1.417	10.000	0.500	0.150	10.000	0.114	0.113	110.000	0.571
3	0.00050	1.417	10.000	0.500	0.150	25.000	0.018	0.018	110.000	0.571
4	0.00050	1.417	10.000	0.500	0.150	50.000	0.005	0.005	110.000	0.571
5	0.00050	1.417	10.000	0.500	0.150	75.000	0.002	0.002	110.000	0.571
6	0.00050	1.417	10.000	0.500	0.150	100.000	0.001	0.001	110.000	0.571
7	0.00050	1.417	10.000	0.500	0.150	150.000	0.001	0.001	110.000	0.571
1	0.00100	2.835	10.000	0.500	0.150	5.000	0.519	0.505	200.000	1.039
2	0.00100	2.835	10.000	0.500	0.150	10.000	0.130	0.129	200.000	1.039
3	0.00100	2.835	10.000	0.500	0.150	25.000	0.021	0.021	200.000	1.039
4	0.00100	2.835	10.000	0.500	0.150	50.000	0.005	0.005	200.000	1.039
5	0.00100	2.835	10.000	0.500	0.150	75.000	0.002	0.002	200.000	1.039
6	0.00050	1.417	10.000	0.500	0.150	100.000	0.002	0.002	200.000	1.039
7	0.00050	1.417	10.000	0.500	0.150	150.000	0.001	0.001	200.000	1.039

TABLE 2-2

SUMMARY OF VOLATILE ORGANIC COMPOUNDS (NOVEMBER 2000) PRESENT IN MONITORING WELL LOCATED WITHIN 200 FEET OF PUMPING WELL PW-1D

FUSRAP MAYWOOD SUPERFUND SITE, MAYWOOD, NJ

GWRI Site Name:	Analysis Name:	Result (ppb)	Result Qualifier*	Higher of NJGWQC or NJ PQL (ppb)	NJMCL/Federal MCL (ppb)	Min. of either NJGWQC or Federal/State MCL (ppb)	Exceedance of Minimum GW. Criteria
B38W25S	Chlorobenzene	0.1	J	4	N/A	4	-
	Ethylbenzene	0.2	J	700	700	700	-
	Toluene	0.7	J	1000	1000	1000	-
	Total Xylene	0.9	J	40	1000	40	-
B38W25D	Benzene	0.4	J	1	1	1	-
	Chlorobenzene	0.2	J	4	N/A	4	-
	Ethylbenzene	0.2	J	700	700	700	-
	Toluene	1		1000	1000	1000	-
	Total Xylene	0.9	J	40	1000	40	-
MISS05B	1,1-Dichloroethane	0.2	J	70	50	50	-
	1,2-Dichloroethene (total)	0.8	J	10	70	10	-
	4-Methyl-2-pentanone	5	J	400	N/A	400	-
	Chlorobenzene	8		4	N/A	4	yes
	Ethylbenzene	0.9	J	700	700	700	-
	Toluene	6		1000	1000	1000	-
	Vinyl Chloride	0.2	J	5	2	2	-
B38W19S	Ethylbenzene	0.2	J	700	700	700	-
	Toluene	0.7	J	1000	1000	1000	-
B38W19D	1,2-Dichloroethene (total)	0.5	J	10	70	10	-
	Benzene	1		1	1	1	-
	Chlorobenzene	0.4	J	4	N/A	4	-
	Ethylbenzene	0.1	J	700	700	700	-
	Toluene	0.4	J	1000	1000	1000	-

Legend

ppb - parts per billion
* - Indicates Laboratory Data Qualifier. Data has not been validated in accordance with USACE criteria as of preparation of this table
J - Estimated Concentration
N/A - Not Available
NJGWQC - New Jersey Groundwater Quality Critieria
NJ PQL - New Jersey Practical Quantitation Limit
MCL - Maximum Contaminant Level

TABLE 2-3

SUMMARY OF RADIOLOGICAL PARAMETERS (NOVEMBER 2000) PRESENT IN MONITORING WELL LOCATED WITHIN 200 FEET OF PUMPING WELL PW-1D

FUSRAP MAYWOOD SUPERFUND SITE, MAYWOOD, NJ

GWRI Site Name:	Analyte	Analytical Result (pCi/L)	Sum of Radiological Isotopes (pCi/L)	Federal MCL (pCi/L)		Exceedance of Federal MCL
B38W25S	RA-226	1.02	1.69	5		-
	RA-228	0.67				
	TH-228	0.19	0.84	15	*	-
	TH-230	0.39				
	TH-232	0.26				
	U-234	0.37	0.68	27	**	-
	U-235	0.07				
	U-238	0.24				
B38W25D	RA-226	0.69	0.81	5		-
	RA-228	0.12				
	TH-228	1.27	2.22	15		-
	TH-230	0.79				
	TH-232	0.16				
	U-234	0.39	0.72	27		-
	U-235	0.14				
	U-238	0.19				
MISS05A	RA-226	1.39	3.88	5		-
	RA-228	2.50				
	TH-228	2.38	5.19	15		-
	TH-230	2.45				
	TH-232	0.35				
	U-234	35.02	73.48	27		Yes
	U-235	1.96				
	U-238	36.50				
MISS05B	RA-226	0.17	2.19	5		-
	RA-228	2.02				
	TH-228	1.59	2.38	15		-
	TH-230	0.56				
	TH-232	0.23				
	U-234	3.65	4.33	27		-
	U-235	0.49				
	U-238	0.19				
B38W19S	RA-226	0.63	2.74	5		-
	RA-228	2.10				
	TH-228	0.00	1.46	15		-
	TH-230	1.20				
	TH-232	0.27				
	U-234	0.72	1.34	27		-
	U-235	0.00				
	U-238	0.62				
B38W19D	RA-226	0.59	0.97	5		-
	RA-228	0.38				
	TH-228	0.00	1.06	15		-
	TH-230	1.07				
	TH-232	0.00				
	U-234	0.69	0.96	27		-
	U-235	0.18				
	U-238	0.09				

Legend

Units in picocuries per liter (pCi/L)
RA - Radium
TH- Thorium
U - Uranium
MCL - Maximum Contaminant Level
* - Total Thorium concentrations are compared to the Gross Alpha MCL of 15 pCi/L
** -Multiplier of 0.9 used to convert from MCL in micrograms per liter (ug/L) to pCi/L
Analytical data has not been validated in accordance with USACE critieria as of prepartion of this table

TABLE 2-4

DETERMINATION OF PUMPING RATE BASED ON HYDRAULIC PARAMETERS
UNCONFINED AQUIFER

FUSRAP MAYWOOD SUPERFUND SITE
MAYWOOD, NJ

	Given								Determine	
Trial	K	K	Hr	t	Sy	r	s	s'	Q	Q
	cm/sec	ft/day	ft	day	unitless	ft	ft	ft	ft3/day	gpm
1	0.00010	0.283	12.000	0.330	0.150	0.330	8.000	5.333	182.769	0.949
2	0.00010	0.283	12.000	0.330	0.200	0.330	8.000	5.333	148.502	0.771
1	0.00014	0.397	12.000	0.330	0.150	0.330	8.000	5.333	201.495	1.047
2	0.00014	0.397	12.000	0.330	0.200	0.330	8.000	5.333	170.512	0.886
Trial	K	K	Hr	t	Sy	r	s	s'	Q	Q
	cm/sec	ft/day	ft	day	unitless	ft	ft	ft	ft3/day	gpm
1	0.00010	0.283	12.000	3.000	0.150	5.000	2.905	2.553	148.500	0.771
2	0.00010	0.283	12.000	3.000	0.150	10.000	0.726	0.704	148.500	0.771
3	0.00010	0.283	12.000	3.000	0.150	30.000	0.081	0.080	148.500	0.771
4	0.00010	0.283	12.000	3.000	0.150	50.000	0.029	0.029	148.500	0.771
5	0.00010	0.283	12.000	3.000	0.150	75.000	0.013	0.013	148.500	0.771
6	0.00010	0.283	12.000	3.000	0.150	100.000	0.007	0.007	148.500	0.771
7	0.00010	0.283	12.000	3.000	0.150	150.000	0.003	0.003	148.500	0.771
1	0.00014	0.397	12.000	3.000	0.150	5.000	3.094	2.695	200.000	1.039
2	0.00014	0.397	12.000	3.000	0.150	10.000	0.774	0.749	200.000	1.039
3	0.00014	0.397	12.000	3.000	0.150	30.000	0.086	0.086	200.000	1.039
4	0.00014	0.397	12.000	3.000	0.150	50.000	0.031	0.031	200.000	1.039
5	0.00014	0.397	12.000	3.000	0.150	75.000	0.014	0.014	200.000	1.039
6	0.00014	0.397	12.000	3.000	0.150	100.000	0.008	0.008	200.000	1.039
7	0.00014	0.397	12.000	3.000	0.150	150.000	0.003	0.003	200.000	1.039

Legend

K - Hydraulic Conductivity (cm/sec or ft/day)
H - Aquifer Saturated Thickness (ft)
t - Time Days
Sy - Aquifer Specific Yield (unitless)
r - Radius of pumping well or distance from pumping well as specified, (ft)
s - Drawdown (ft)
s' - Adjusted Drawdown (ft)
Q - Flow Rate in cubic feet per day (ft3/da) or gallons per minute (gpm), as specified